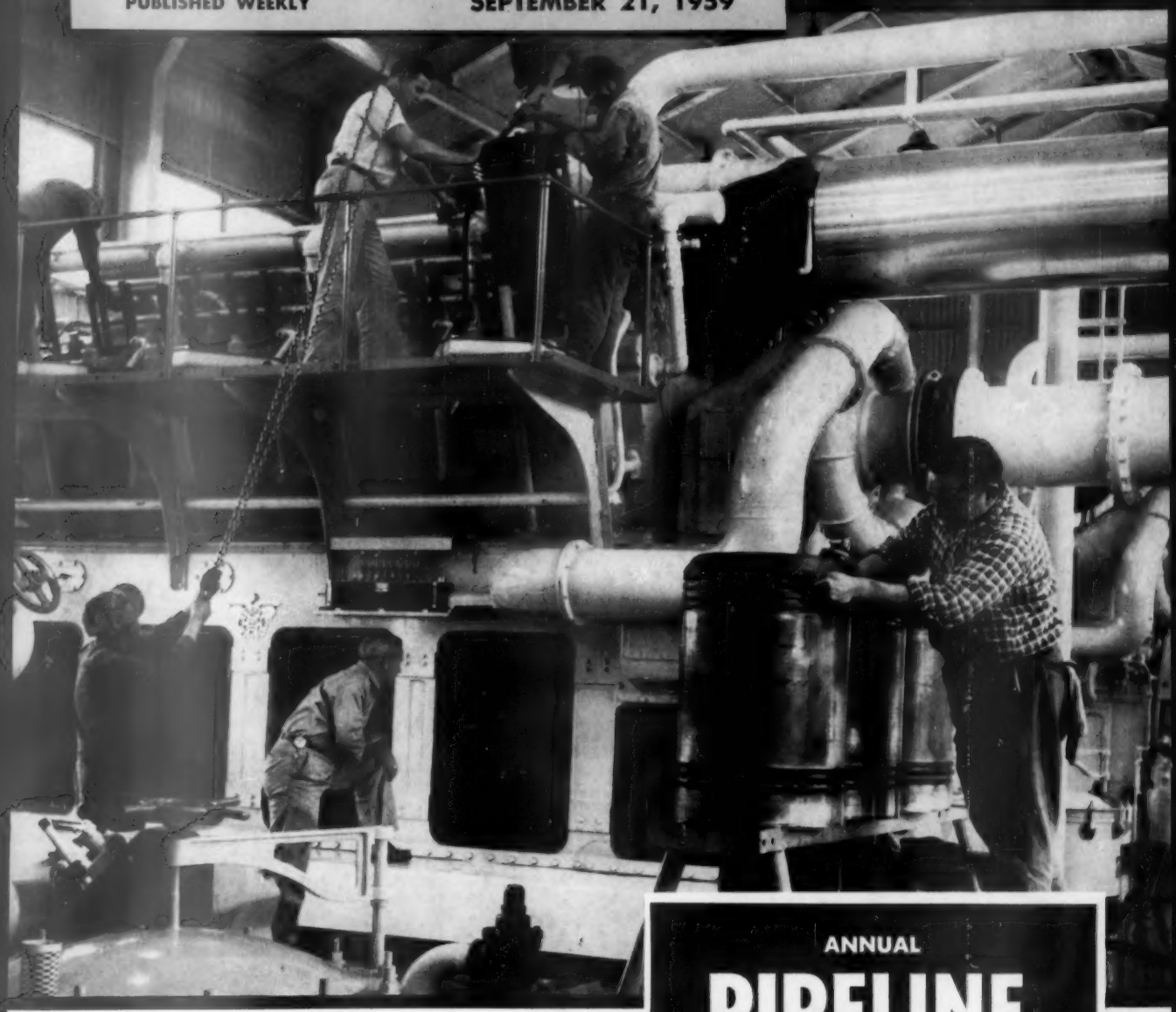
the OIL AND GAS JOURNAL

PUBLISHED WEEKLY SEPTEMBER 21, 1959



Where the Kentucky play is spreading ▸ 106

Kuwait: 10,000-bbl. capacity per well ▸ 118

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ANNUAL

PIPELINE

NUMBER

. . . A 15-page "HOW TO" section on line and station maintenance—plus 30 pages of articles on construction and operation—plus new wall maps of crude oil and products pipelines.

p.123

A NEW VALVE SEAT IN SECONDS— FOR PENNIES

EVERY TIME A ROCKWELL-NORDSTROM LUBRICATED PLUG VALVE IS LUBRICATED (WHETHER ONCE A DAY OR ONCE A YEAR) IT'S LIKE COMPLETELY RESEATING AN ORDINARY VALVE. *PRESSURIZED* LUBRICANT CREATES A NEW, POSITIVELY LEAKPROOF SEAL ON EVEN TOUGHEST REFINERY AND GASOLINE PLANT SERVICES . . . AND LUBRICATION IS PREVENTATIVE MAINTENANCE FOR LONGER VALVE LIFE AT FAR LOWER COST.

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OIL AND GAS JOURNAL
Vol. 57 No. 39

Contents September 21, 1959

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Annual index available on request.

ANNUAL PIPELINE NUMBER

Pipeliners Report on Maintenance 124
By Paul Reed and Gene Kinney
A 15-page special report by the Journal's pipeline editors reflects what's new, important, and interesting to top pipeliners based on an industry-wide survey and interviews covering pumping and compressor stations and pipelines.

Shortcut to Pump Selection for Least Power Consumption 140
By Marlan G. Jordan
An ingenious hydraulic nomograph offers a simple method for selecting pumping units to fit hydraulic conditions resulting from varying shipper's terminal demands along a products line. Two-color illustrations show step-by-step use.

Pure Transportation Completes Automation of Texas Trunk Line ... 144
By R. M. Thoman and G. J. Willer, Jr.
Automation of an old crude line has proved to be a beneficial change and has reduced operating costs. Telemetering operating data to a central point has permitted operations which were previously considered impractical.

How Love Field Gets Fuel by Pipeline 158
By D. D. Compton and H. E. Bahr
New Humble system makes Love Field at Dallas the third municipal airport in the U. S. with a pipeline connection. Separate internally coated lines were laid for avgas and jet fuel, rubber balls are used at interfaces, products are metered at both ends of short line, and separate meter-proving facilities are provided.

Low-Hydrogen Electrodes and Special Joints for Hot Taps 171
By Robert S. Ryan and Robert R. Wright
Basic factors associated with underbead cracking are described along with a welding procedure developed for Columbia Gas which utilizes a special joint design and low-hydrogen electrodes for all grades of API 5XL pipe.

A New Tool for Obtaining Proper Engine Balance 182
By Hugh E. Fisher
Pi-meter offers promise of better engine balance easier and quicker and thus aids in reducing fuel consumption. The instrument indicates mean-cylinder pressure.

What Trunkline Has Learned About Compressor-Station Lubrication .. 184
By Cecil R. Carter
Conclusions on types of oil, oil filtration, centrifugal oil cleaning, synthetic lubricants, nonlubricated packing, and aluminum bearings are based on test results that have indicated improved operations.

Better Tools for Better Pipeline Upkeep 196
By Alva C. Smith
Some of the most important maintenance developments and their significance are cited in terms of job performance and over-all industry welfare.

Why Reciprocating Compressors Act as They Do 201
By C. S. Kenworthy
Questions often raised as to the behavior of reciprocating compressors are answered after a logical step-by-step development of the various concepts encountered in the compression cycle.

Two Pipe Gangs Put Down 6-In. At Rate of 5 Miles Per Day 204
By Gene Kinney
Use of two pipe gangs on one construction spread increased production 44% with minor personnel and equipment additions elsewhere.

Midwestern Construction Practices Are Different 207
By Paul Reed
Project includes plastic external coatings, internal coating for most of its length, and varied approaches to other construction jobs.

TECHNOLOGY—OPERATION

How to Stimulate a Well in a Depleted Reservoir 210
By Norman Lamont

E. P. Lubricants in Drilling Muds Offer Many Advantages 213
By W. C. Browning

Operating Report: Sohio's Dual Gas-Recovery System 223
By Larry Resen

Use of Radioisotopes for Interface Detection in Products Pipelining ... 227
By C. W. Blackburn

the OIL AND GAS JOURNAL Newsletter

Tulsa, Okla.
Sept. 21, 1959

Congress has gone home now until January:

Outlook for next year: No drastic oil issue on tap when the lawmakers return (p. 104).

Still unfinished, however, are a possible struggle over depletion allowance, changes in leasing laws, legal controls on imports, restrictions on foreign tankers, pricing controls, advance notification on mergers, and plans for a national fuels policy.

Accomplished was a 1-cent per gallon increase in the federal gasoline tax, protection for buyers of leases originally obtained by others in violation of acreage limits.

▼ ▼ ▼

Trends of the time: Two majors announce the hiring of Washington public relations experts to promote the firms' welfare in the nation's capital.

Continental named Basil R. Littin as associate director of public affairs specializing in government relations. He also will be responsible for service and liaison in Washington for Continental's divisions and subsidiaries (p. 104).

Gulf named Henry LaCossitt, newspaper and magazine editor and publicist, as its public relations representative in the capital. He will work with Gulf's new political information program and will write a political analysis biweekly for the company.

▼ ▼ ▼

Pan American is actively going after more intrastate markets for its natural gas.

This is a follow up of its recent deal to sell gas from Old Ocean field to Texas Electric Service Co. for use in operating electric generating plants.

Also prompting the move: FPC doesn't regulate intrastate gas. Other companies are planning similar moves (p. 101).

A record $763 million worth of gas transmission facilities was approved by FPC in 1959 fiscal year.

This involved nearly 4,900 miles of pipeline, 614,000 hp. of compressor units.

Other highlights: Marketed production topped 11 tril-

lion cubic feet...Wellhead price averaged 11.9 cents M.c.f., an increase of 0.6 cent...Consumer price averaged 46.2 cents M.c.f., increase of 3.1 cents.

▼ ▼ ▼

Crude-price news is slightly better.

California Standard posted cuts on California crude ranging from 5 to 25 cents a barrel which is just about half as much as cuts posted earlier by Union and General Petroleum.

Pennsylvania-grade crude is getting a 15-cent price advance. Top is $4.40 for Bradford district oil. Increase was attributed to strong demand.

The bottom has dropped out of demand.

Total demand for four major products averaged only 6,350,000 bbl. daily for week ended September 11. This is low week for year despite fact it included Labor Day.

Note on inventories: LPG stocks also are at all-time high of 1,025,765,000 gallons, 35.1% gain for year...Propane accounted for more than three-fourths of gain...Nearly 88% of inventories are in underground storage.

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Industry meetings are hearing some harsh words.

At NPA sessions, J. Ed Warren of Cities Service says oil's long-term outlook is very strong but its position at the moment is alarming.

His suggestion: Keep lid on inflationary costs arising from taxes and outside sources...Resist surrender of any incentives now available to the industry...Individually consider means of reducing costs, eliminating inefficiency.

At ACS gathering, J. A. Field of Union Carbide reports sales of organic petrochemical intermediates should more than double to $4.25 billion by 1963.

His warning: Extraordinary efforts must be made to expand markets and find new ones to absorb present overcapacity in the industry.

At Texas Mid-Continent Oil and Gas meeting, Jake Hamon scores mismanagement of crude inventories as causing the ruin of domestic producers.

He says this task should be taken from refiners and marketers of the 30 big companies and assumed by top management.

▼ ▼ ▼

Jersey Standard and Socony Mobil reorganizations have

been given close legal scrutiny from Texas attorney general.

The result: Nothing in Texas statutes or past court decisions bar shakeups involving Humble or Magnolia.

High mortality rate among service stations is subject of new marketing study just completed.

Cause for failure: Low profit margin, insufficient working capital, poor management involving inadequate bookkeeping and training, lack of specific help from the oil companies.

▼ ▼ ▼

A 24-in. pipeline has been proposed to move coal from the fields of Western Pennsylvania and West Virginia to the New York-Philadelphia area.

Four major East Coast utilities are backing the idea. It's similar to the line now operating successfully between Cadiz, Ohio, and Cleveland.

The deal: Builder and operator would be Texas Eastern Transmission, which already has the right-of-way and would build the new line parallel its existing lines. Fuel would be supplied by Consolidation Coal Co., operator of the Cadiz-Cleveland line.

Utilities interested are Consolidated Edison, Public Service Electric & Gas of New Jersey, Pennsylvania Power & Light of Allentown, Pa., and Philadelphia Electric.

Italy intends to have share of Europe's expanding pipeline network.

ENI will build crude system north from Genoa to move 240,000 bbl. daily to refineries in northern Italy, Switzerland, and southern Germany. Oil will come from Iran, Egypt. ENI also is surveying possible markets in England.

▼ ▼ ▼

North Africa drilling still produces hot news:

Creps wildcat, the 1 Ouan Taredjeli, has shows in five known zones. It's being drilled deeper from 3,670 ft. Location is 8 miles northeast of Zarzaitine field.

Gulf has completed discovery in Northwest Libya good for 900 bbl. daily. Its 1 Emgaset is 200 miles south of Tripoli in center of Concession 66. More drilling will be needed to determine reserves.

Green County is settling down. Production has dropped from 51,000-bbl. peak of last May. Drilling is off sharply from frantic pace of last spring (p. 106).

But oil play is far from over.

Exploratory drilling has fanned out through central sections of Kentucky, Indiana, and Tennessee. Also much work remains to be done right in the Greensburg region.

First commercial oil discovery in Philippines may have been made by locally-owned Republic Resources & Development Corp.

Two tests found at least five productive zones in the company's wildcat 30 miles west of Cebu City.

Tough news from Alaska—General Petroleum's 1 Great Basin wildcat near Becharof Lake on the Alaska Peninsula has been abondoned at 11,080 ft.

The test apparently was in basement rock when abandoned. It was the first test on a 455,573-acre development contract and was rated a very important well. A second well will be drilled soon 14 miles northwest of the first.

▼ ▼ ▼

Refinery strikes linger on.

At Texas City, Amoco and OCAW agreed in court on plan to prevent violence. Court injunction backs up agreement. No progress has been reported, meanwhile, in settling strike.

At Sugar Creek, Mo., violence resulted in negotiations being broken off. Similar stalemate exists at El Dorado, Ark.

Refiners are tightening purse strings for research.

Research and development budgets of 19 refiners this year increased only 1.4% over 1958, according to annual analysis by the American Management Association. Twelve firms increased budgets, five kept them the same, two cut.

Refining actually showed lowest increase in research budget of 23 industries surveyed. Top gains were made by automobiles (32.1%), instruments (29.7%) and electrical machinery (23.8%).

▼ ▼ ▼

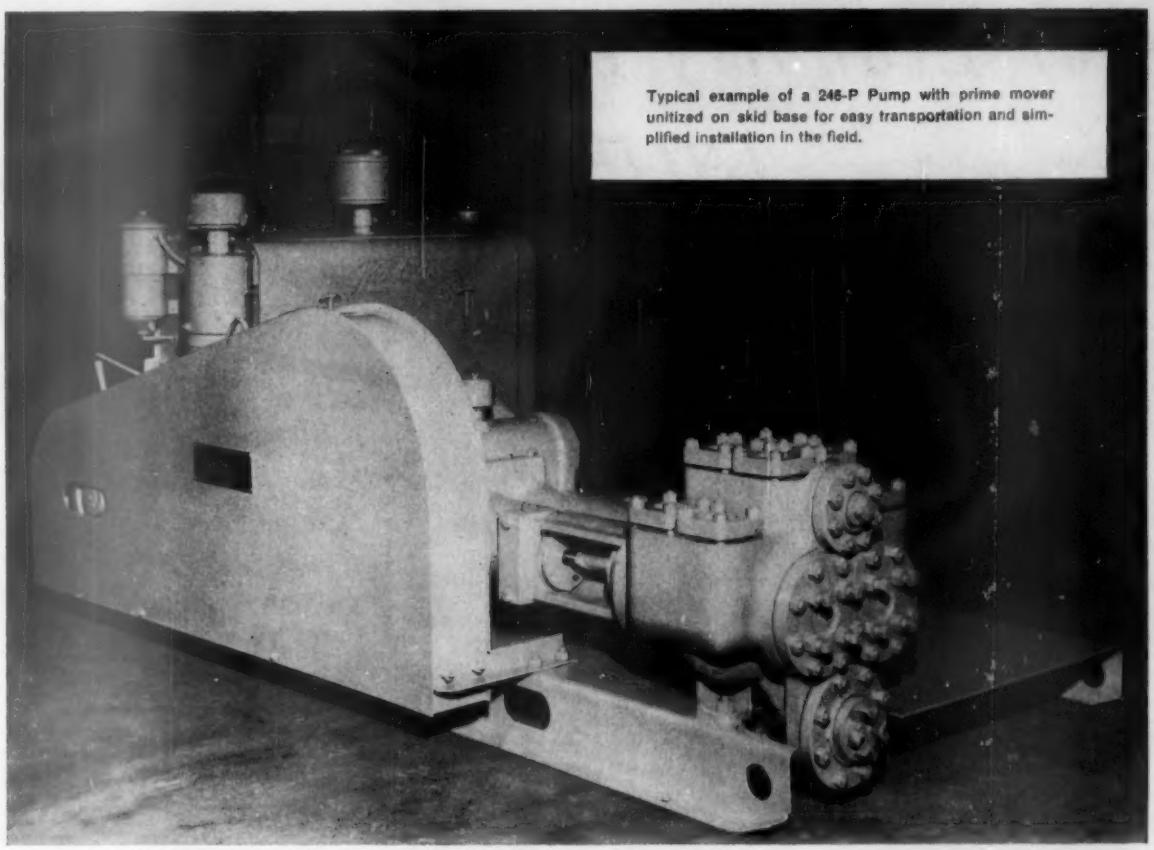
Interesting new uses of asphalt have been turned up by Esso Research to:

...Stimulate growth of grass in arid areas. An asphalt film is placed over grass seed buds to save moisture. It is formulated to last the 5 or 6 weeks needed for seed germination and breakthrough.

...Alleviate dust-bowl conditions. Alternate strips of dusty, dry land are covered by asphalt coatings. Rain runs off the waterproofed strips and is diverted to acreage where cultivation is desired.

Combustion index analagous to the octane scale is now available for grading fuel oil for home burners.

Socony Mobil has come up with a micro test burner which makes it possible to set up a combustion index to indicate the amount of smoke that will be produced in full-scale equipment.



Typical example of a 246-P Pump with prime mover unitized on skid base for easy transportation and simplified installation in the field.

See "Oilwell's" NEW Power Pump for oil gathering operations

Model 246-P – 4″ x 6″

Low profile, together with compact yet accessible design, makes the 246-P easy to unitize with the prime mover of your choice. It is a double-acting duplex with all the best features pipeliners want. Piston sizes range from 2½ to 4 inches.

The power end is designed in one piece, with marine-type connecting rods and an efficient splash lubrication system. Crankshaft, and pinion shaft with integral pinion gear, are mounted in field-adjustable, tapered roller bearings.

The fluid end is a one-piece design with removable, packed-off liners, snap-ring pistons, and wing-guided valves and seats. Piston rods are equipped with fluid baffles. Piping hook-up is simplified by the end-suction and end-discharge arrangement.

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Piston Size Range Inches	Rated Working Pressure (psi)	Barrels per 24 Hours at Pump Speeds (rpm) of:			
		40	60	80	100
2½	900	651	960	1,269	1,612
3	600	942	1,415	1,885	2,360
3½	450	1,310	1,965	2,620	3,275
4	350	1,730	2,590	3,455	4,320
Brake Horsepower Required		11.5	17.1	22.9	28.5

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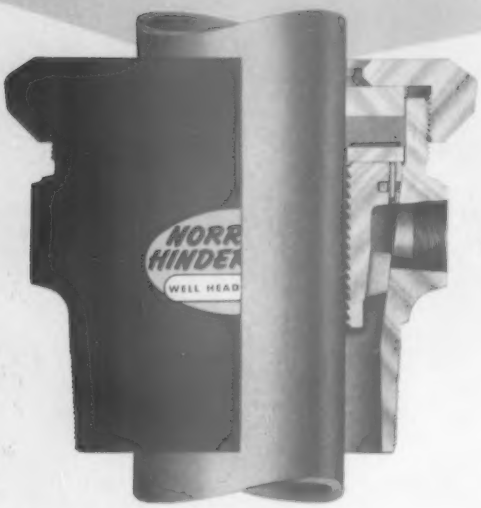
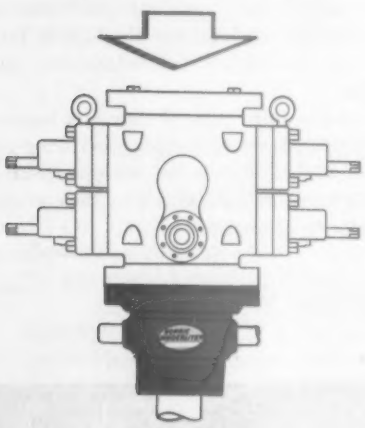


- *Full Opening Bore*
- *Removable Drilling Flange*
- *Male or Female Threads*
- *4000# Test*
- *150,000# Rated Load Carrying Capacity*

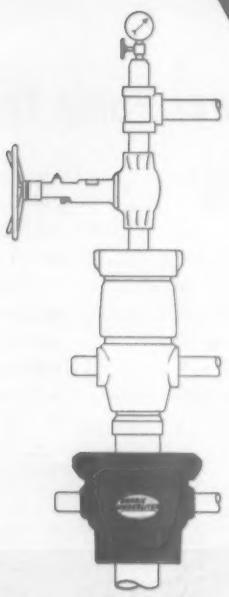
ADAPTABLE TO ALL DRILLING, FLOWING OR PUMPING WELLS TO 2000# WORKING PRESSURE

To Save Money:

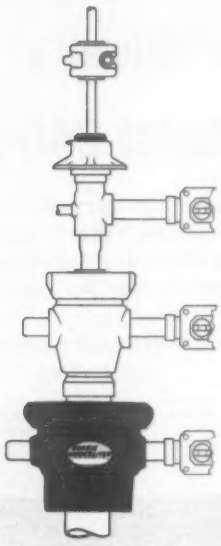
YOU CAN ASSEMBLE YOUR OWN HOOK-UP



DRILLING



FLOWING



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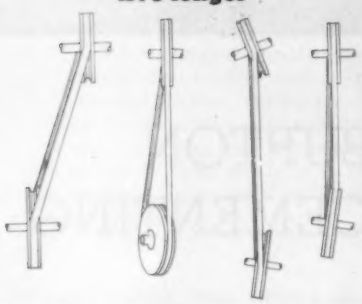
B.F.Goodrich V belt briefs

TIPS ON THE CARE, MAINTENANCE AND SELECTION OF V BELTS FOR INDUSTRY

Belts that go straight live longer



When V belts enter and leave the pulley grooves at an angle, it causes the sides of the belts and pulley sidewalls to wear excessively. This condition can be caused by drive shafts that aren't parallel, by sheaves that are out of line, by wobbly sheaves, or by a bent drive shaft.

Simple instructions on how to make sure that the drives are parallel, and to check for wobbly sheaves or bent drive shafts can be found in the B.F.Goodrich V belt maintenance manual. Ask your B.F.Goodrich distributor for a copy.

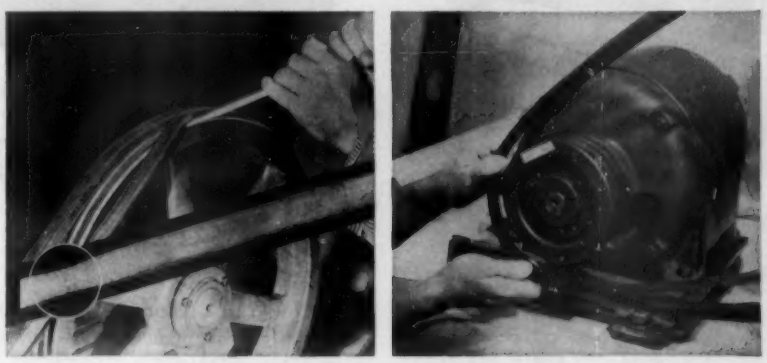
What do V-belt sizes mean?

V belts are marked with a letter which indicates their width across the top and a number to indicate their length. Standard belt widths are coded: A, B, C, D and E.

Here are the belt cross sections and minimum recommended pitch diameters to obtain maximum V-belt life.

Section	Recommended Range of Small Sheave Diameters (Inches)	Absolute Minimum Pitch Diameter (Inches)
A	3.0" to 5.0"	2.6
B	5.4" to 7.5"	4.6
C	9.0" to 12.0"	7.0
D	13.0" to 20.0"	12.0
E	21.0" to 28.0"	18.0

Which is the right way to install V belts?

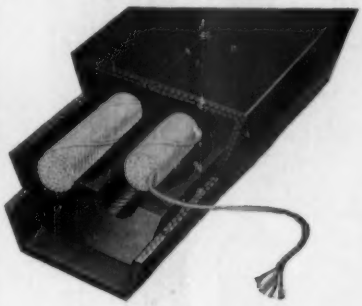


V belt at left is not being installed correctly. When a belt is forced into the sheave with a screwdriver or any other wedge, the outer fabric is often ruptured and cords broken. To install V belts correctly, move driver unit forward so belts can be slipped easily into sheave groove without damage.

What caused this V belt failure?

Answer: There could be several causes: Severe back bend idlers, improper storage, or excessive ambient operating temperatures. To prevent, check storage conditions. If back bend idler cannot be avoided, figure number of belts again with additional service factor. (See B.F.Goodrich Multi-V belt handbook.) Avoid ambient temperatures over 150°.

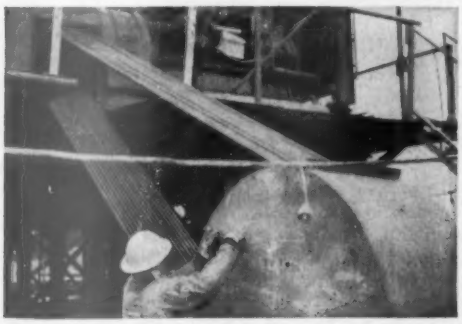
Here's why Grommet belts grip better



See all the rubber surrounding the twin grommets in this B.F.Goodrich belt? It has more rubber in relation to belt size than any other belt. Grommets are cord loops made like twisted cables, except they are endless. Because these grommets are endless, have no stiff overlapping cords, they are more flexible, grip the sheaves better. Size for size, Grommet belts give ⅓ more gripping power with less slip.

Call our oil field warehouses

For help in selecting V belts for any kind of service, call any of these B.F.Goodrich warehouses: Los Angeles, Great Bend, New Orleans, Hobbs, Oklahoma City, Tulsa, Dallas, Houston, Odessa, Wichita Falls. *B.F.Goodrich Industrial Products Co., Dept. M-687, Akron 18, Ohio.*



Keep mud pumps pumping— Driving mud pumps is rough on V belts. They're jolted by shock loads, must stand dirt, dampness, all kinds of weather. B.F.Goodrich Grommet belts have proved they can take this kind of abuse. They're stronger, stand shocks better, don't stretch or slip as much as other belts. They eliminate frequent take-ups, prevent costly breakdowns, and, in some oil field installations, have tripled belt service.

B.F.Goodrich V belts

"WELL DESIGNED" FOR REMEDIAL PROBLEMS

HALLIBURTON SQUEEZE CEMENTING

"DM-DC" Drillable Squeeze Packer

Variable conditions in down-hole trouble spots require especially designed cement slurries and applications, to aid in the correction of these problems.

Halliburton Squeeze Cementing has been the answer for well owners in the selection of the proper solution for many years for many of these frequent problems:

- Repair of casing leaks
- Isolation of producing zones prior to perforation
- Correction of channeling problems
- Sealing off of low pressure thieving formations
- Abandonment of depleted producing zones

For a "well designed" squeeze job for your individual well requirements... backed-up by unmatched experience, equipment and materials ... specify Halliburton Squeeze Cementing, you'll save time, money and worry.

HALLIBURTON COMBINES...

TOOLS and TECHNIQUES for BETTER SQUEEZE CEMENTING

"DM-DC" DRILLABLE SQUEEZE PACKERS

Here is another excellent example of Halliburton's integration of tools and techniques. Simple and easy to set, these dependable packers run on drill pipe, tubing, drilling line or electrical well service wire line. When set by tubing or drill pipe, the circulating valve is free from packer before squeezing begins. Back Pressure Valve is closed as packer is set, providing positive fluid shut-off from below. Packer becomes a Bridge Plug when Sealing Plug or Ball is dropped or pumped in place after packer is set.

HALLIBURTON WIRE LINE HYDRAULIC SETTING TOOL...

That requires *only* rig sand or drilling line to set Halliburton Drillable "DM"-"DC" Bridge Plugs and Squeeze Packers or Type "CL" Production Packers... Eliminates special set-up and footage charge of wire line specialty company... Saves expensive rig time as compared with setting packer on tubing. Setting tool can be used in wells with or without fluid as hydraulic setting fluid is contained in the tool ... freeing itself for removal by hydraulic force.

HALLIBURTON RETRIEVABLE TEST-TREAT-SQUEEZE PACKER (RTTS)

Advanced design of this retrievable packer permits greater application versatility. A multi-purpose hook wall type retrievable packer with full opening mandrel allows easy adaptability for combination testing, high volume treating and squeezing operations *with only one trip into the hole.* Tubing and annulus pressure is equalized at packer by the circulating valve, and can be locked in open or closed position, opening at any time to allow circulation above packer. Tool may be moved to other positions in the hole where other zones are to be treated. Equipped with safety joint with all parts below made of drillable material.

HYDRO-LOK (PC-11)

A plastic slurry used in wells with bottom hole temperature ranging from 60° to 240°F and can either be pumped or used in dump bailer for better water control. PC-11 forms a permanent plug and is not soluble in known acids and well fluids. Consists of a thermosetting resin and inert solids as bulking agents for squeezing material with fluid loss control. The resin phase squeezed into formation usually sets in less than one hour when it comes in contact with water; generally 2 to 4 hours are required to obtain a set in open hole.

HR-4 CEMENT RETARDER

Used to retard the thickening time of Portland, Pozmix or Latex Cement, allowing placement in wells having higher ranges of temperature. A powder which can be added to bulk cement or to the mixing water with equal success. With Latex Cement, HR-4 improves the filtration properties at higher temperatures.

DIACEL LWL (Low Water Loss)

A powdered cellulose derivative (CMHEC) when added in small quantities to cement will produce low filtration rates... may be used with most all types of cementing compositions as a low water loss additive... also as a retarder for deep well cementing.

RTTS (RETRIEVABLE TEST-TREAT-SQUEEZE) PACKER

WIRE LINE HYDRAULIC SETTING TOOL WITH "DC" BRIDGE PLUG

HALLIBURTON

CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

284 SERVICE CENTERS—JUST MINUTES AWAY FROM YOUR WELL

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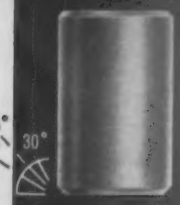
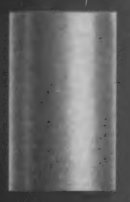


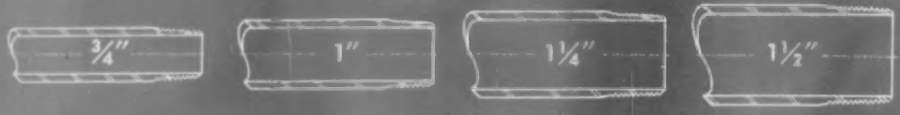
BOTH ENDS BEVELED

ONE END BEVELED

NON-BEVELED

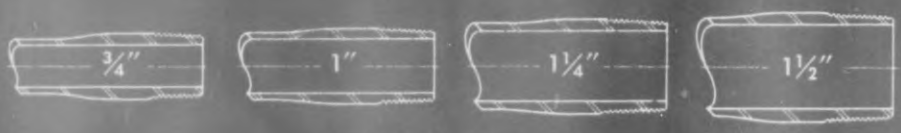


SPECIAL CLEARANCE



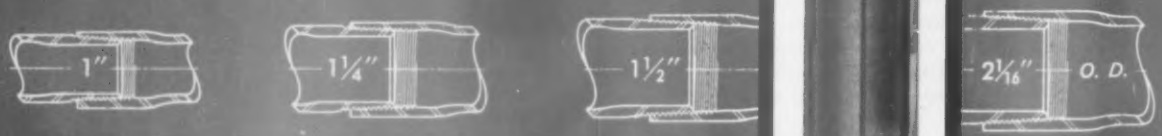
NON-UPSET T & C

for Macaroni Tubing

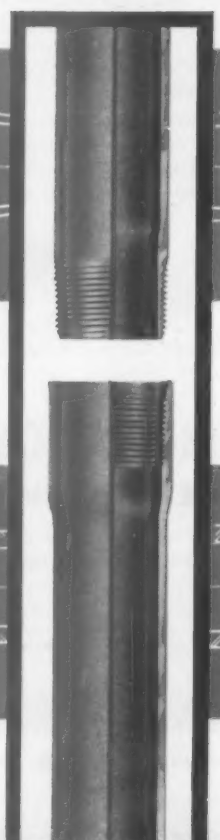


API UPSET T & C

to your Exact Requirements

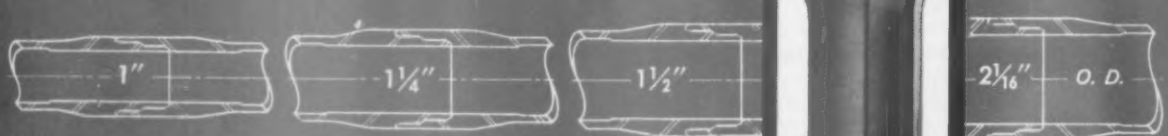


TEX-TUBE 10-RD THD INTEGRAL JOINT



TEX-TUBE, INC.

1503 NORTH POST OAK ROAD • HOUSTON, TEXAS



HEAVY DUTY HIGH PRESSURE INTEGRAL JOINT

Sales Offices in Midland, Texas—Tulsa, Oklahoma— Dallas, Texas—Los Angeles, California

TEX-TUBE INTEGRAL JOINT

PUBLIC SERVICE COMPANY OF OKLAHOMA SYSTEM

INVITATION TO SERVICE...

We cordially invite you to call on us for information on costs and availability of electric service in Oklahoma and for consultation on any electrical problems you may have. Phone CH 2-6171 or write Public Service Company of Oklahoma, B. F. Thompson, Sales Department, Mezzanine, 6th and Main, Tulsa 2, Oklahoma, or the Area Sales Manager in these Public Service Company headquarter towns: Bartlesville, Vinita, Okmulgee, McAlester, Hugo, Duncan, Lawton, Chickasha, and Clinton.

DEPENDABLE ELECTRIC POWER FOR ALL BRANCHES OF THE OIL BUSINESS!

PUSH BUTTON PIPELINE

ANOTHER first from SIE *and Dresser!*

Write Rex Grey for your personal copy of . . .

"Control . . . the answer to increased pipe line profits"

SIE, through solid state electronics brings you the latest developments in remote supervision, computing and control.

- Automatic Sequencing and Load Control
- Data Logging
- Alarm Scanning and Mimic Display
- Deviation and rate-of-change printout and alarm

Designed for long life and reliability with highest data density and scan rate of any system . . . by

Control System Specialists devoted to the oil industry

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.

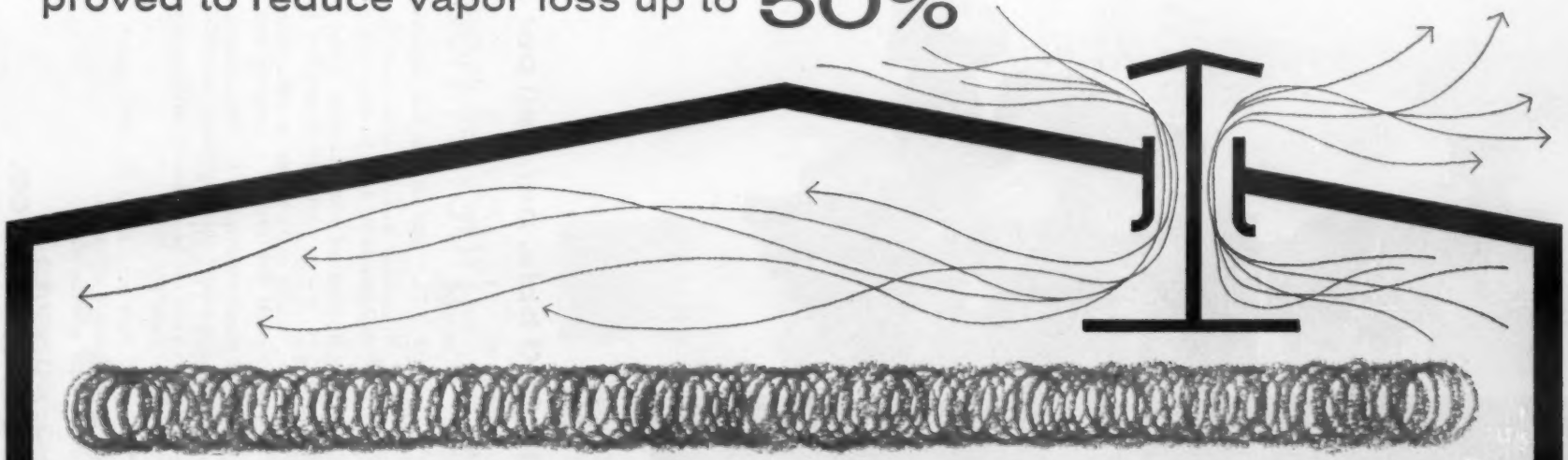
A DIVISION OF DRESSER INDUSTRIES, INC.

10201 Westheimer • P. O. Box 13058 • Houston 19, Texas

CABLE ADDRESS: SIECO HOUSTON TWX: HO 1185

S&J AIR BAFFLE

proved to reduce vapor loss up to 50%



Downward velocity of air jetting into a tank through the breather vent causes currents which induce rapid product evaporation. S & J Air Baffle is a device which deflects incoming air into stratified layers above heavier, gas-rich air. The result is materially reduced surface boiling, with vapor losses cut from 25 to 50%. Unique Air Baffle design permits simple installation through the vent nozzle on tanks in service. Call or write for complete details and prices.

SHAND AND JURS

GENERAL PRECISION EQUIPMENT CORPORATION GPE

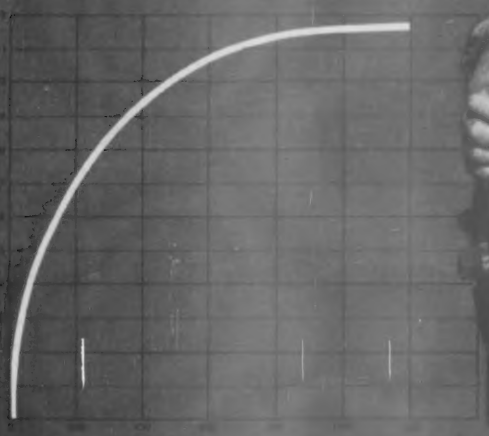
SHAND AND JURS COMPANY

2600 Eighth Street, Berkeley, California

A Subsidiary of General Precision Equipment Corporation
Branch offices and representatives in principal cities

Flow area thru UNIBOLT ADJUSTABLE WING VALVE
Passes Large Quantities of Fluid or Gas

FLOW OF WATER THROUGH UNIBOLT CHOKE
WITH 1" SEAT



FLOW OF GAS THROUGH UNIBOLT CHOKE
WITH ½" SEAT AT 2000 PSI INLET PRESSURE

if you could produce 10,000 bbls. per well per day . . .

. . . as the charts show, this UNIBOLT Adjustable Wing Valve would handle the fluid with only a 100-lb. pressure drop! Or, you could produce 28 million cubic feet of gas through it with only a 200-lb. pressure drop. So, while the UNIBOLT Adjustable Wing Valve is not a full-opening type, its one-inch flow area is far more than adequate for practically any desired production rate—*and the cost is importantly lower than for conventional gate and plug valves.*

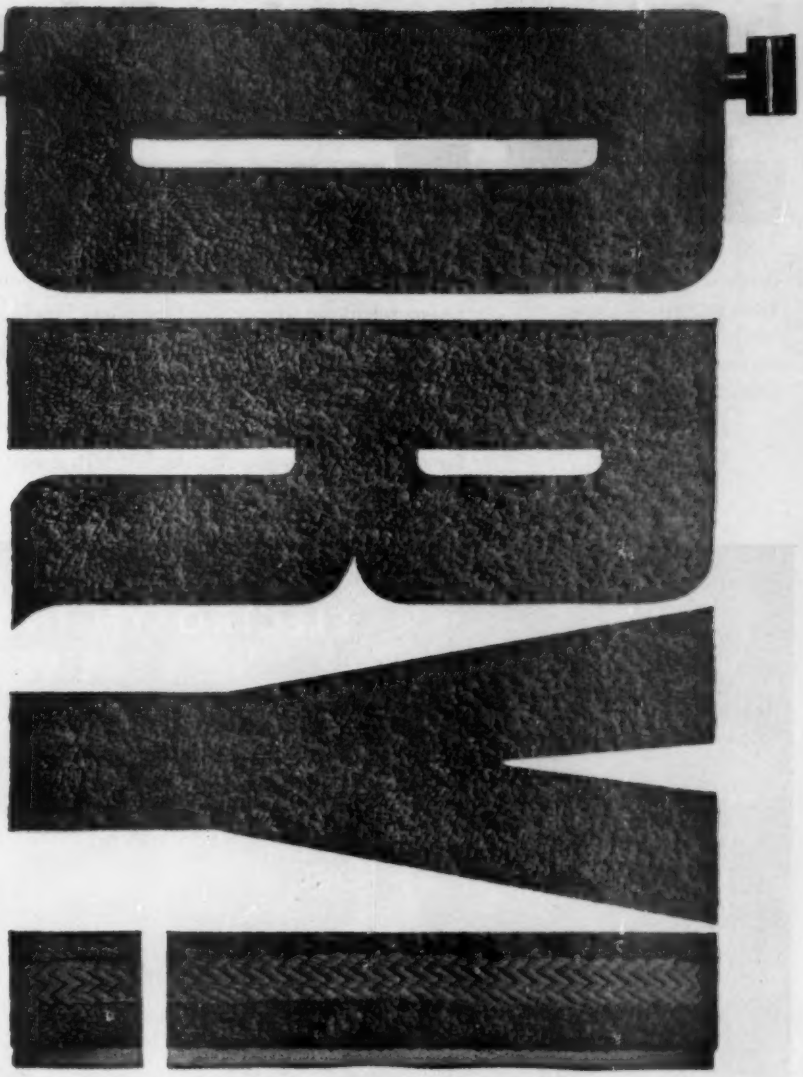
Actually, there's a dozen more good reasons why this UNIBOLT Adjustable Wing Valve is a solid favorite among value-conscious operators:

1. There are no exposed threads . . . no accidental damage.
2. All metal seats . . . not affected by high or low temperature.
3. Stem packing that needs no tightening.
4. Stem turns freely under high pressures.
5. Threads on stem not exposed to external or internal damage.
6. Full 2½" pilot for true stem alignment and rigidity.
7. Streamlined flow—no obstruction, no turbulence or impingement of flow, no negative pressure areas.
8. Requires no grease to effect a seal . . . may also be used as micrometer-gauged flow bean.
9. Variable choke speeds up initial clean-up or running initial flow tests . . . saves rig time.
10. Can be converted to "Pressurematic Safety Valve" by simply changing bonnet assemblies.
11. Valve can be completely overhauled without removal from tree.
12. Stem seat sealed by metal gasket; power threads assure alignment.

THORNHILL CRAVER CO.
P. O. BOX 1184 HOUSTON, TEXAS

DAVISON

When gases must be



Davison Hi-Sorb Silica Gel dries better

That's why Davison Silica Gel is so often to be found in natural gas dehydrators . . . in gas streams . . . in the refinery. Davison Silica Gel prevents hydrate formation which clogs lines, causes high-pressure losses and high maintenance costs. It decreases corrosion in equipment and reduces power costs in compression. Not least—it keeps customers happy! There's nothing better obtainable. Write Department 3119 today for full information.

Department 3119

W.R. GRACE & CO.

DAVISON CHEMICAL DIVISION

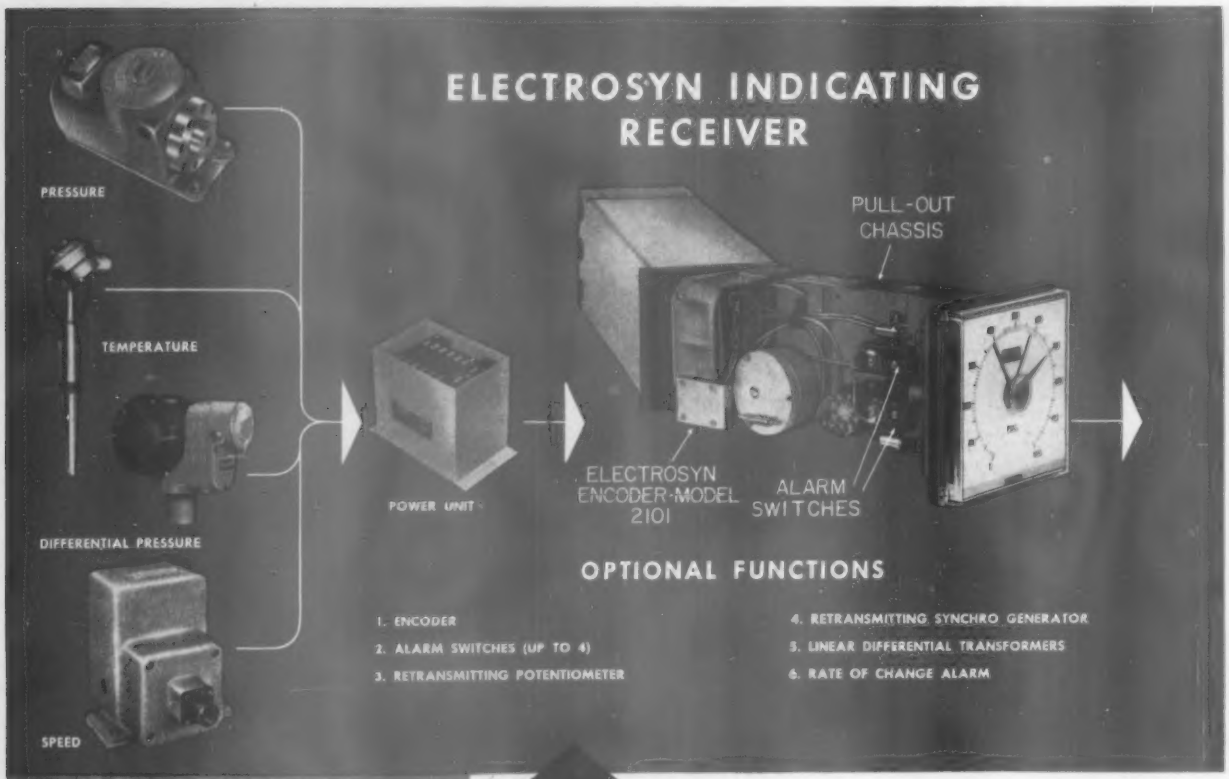
BALTIMORE 3, MARYLAND

3 reasons why Columbia-Gulf

NORWOOD CONTROLS

ELECTROSYN

When Columbia-Gulf Transmission Company engineers first installed digital telemetering equipment on their gas pipelines, Norwood's ElectroSyn System was specified to perform pressure and other measurement and indicating functions. Success of these initial installations has led to repeat orders for ElectroSyn because its low operating and maintenance costs (plus high reporting accuracy) far outweigh its somewhat higher initial cost . . . as the following facts indicate.



PROVEN IN ACTUAL SERVICE

The Norwood ElectroSyn system has proved its compatibility with the leading digital telemetering systems and supervisory control systems. Actual installations are currently helping to cut operating costs for the following well-known users:

SERVICE PIPE LINE CO., TEXAS EASTERN TRANSMISSION CORP., COLUMBIA-GULF GAS TRANSMISSION CO., EL PASO NATURAL GAS CO., SOUTHERN PACIFIC PIPE LINES, INC., ARABIAN AMERICAN OIL CO., LAKEHEAD PIPE LINE CO.

The System

Error signal is amplified by a magnetic servo-amplifier (which can be located up to 4 miles from transmitter). Signal voltage is compared with output from a servo-motor driven feedback ElectroSyn Signal Generator. Pointer on indicator turns until signal and feedback balance and then entire system ceases to move until next transducer signal change.

Write for ElectroSyn Bulletin B258C Norwood Controls Unit, Detroit Controls Division, 942 Washington St., Norwood, Massachusetts.

Transmission Company specified

RELIABILITY

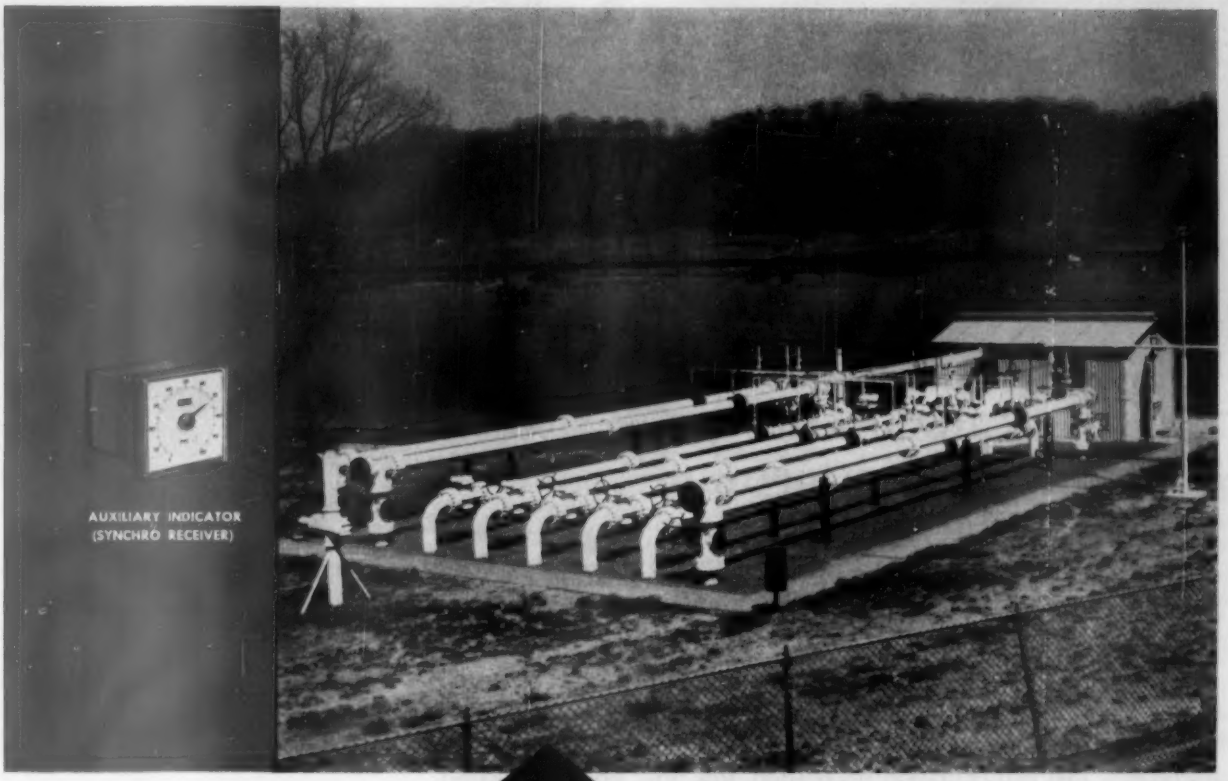
No vacuum tubes, no brush contacts, no moving parts at all under equilibrium conditions. Wear due to friction is so much reduced that truly automated pipeline monitoring and control become both practical and economical.

ACCURACY

Pressure, flow and other data are reported with close to 1% of full-scale accuracy. This not only permits lower safety margin requirements and greater throughput under conditions of high demand but also ensures maximum operating efficiency at lower pipeline pressures.

ECONOMY

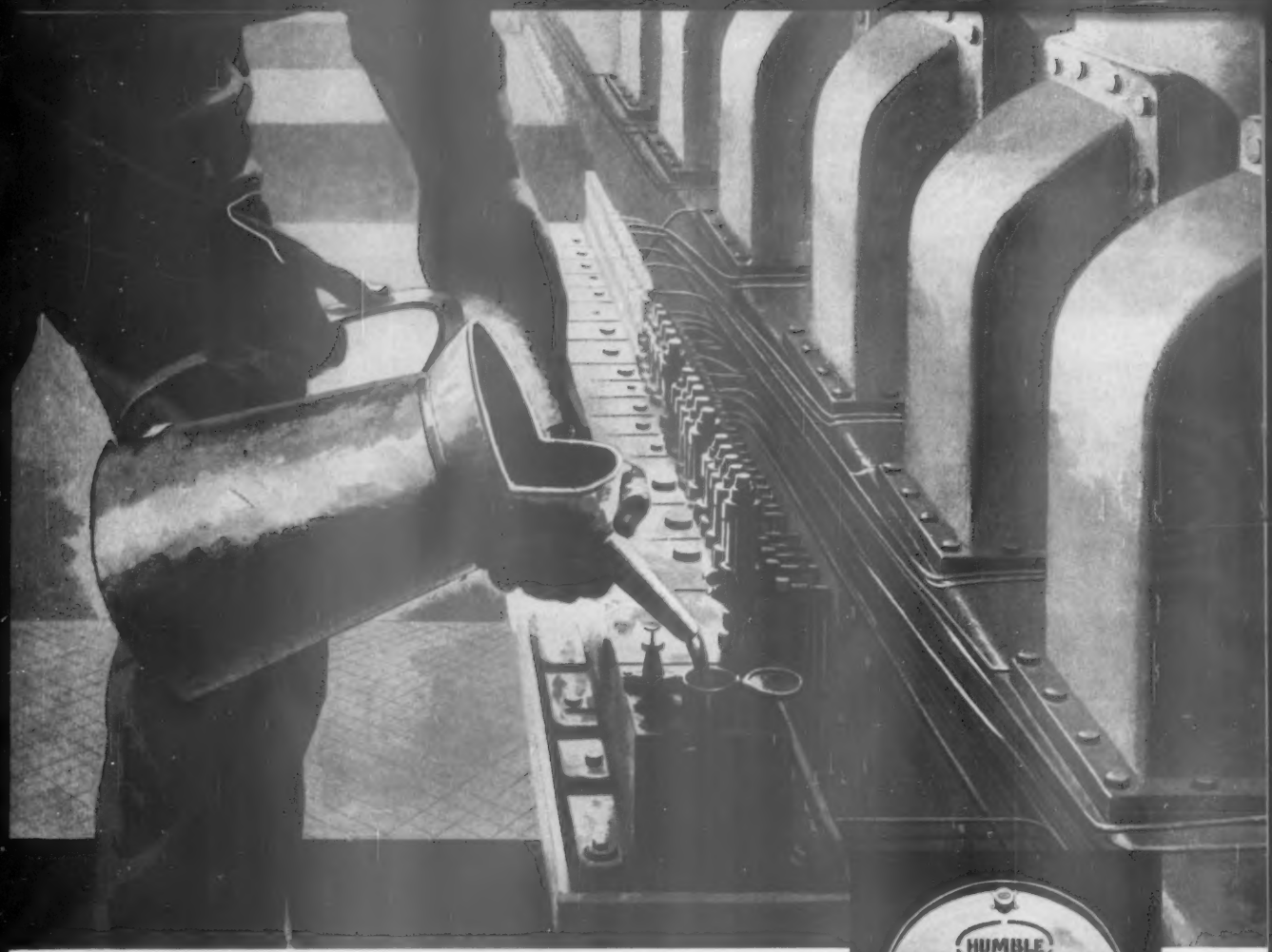
results from both accuracy *and* reliability. ElectroSyn's trouble-free operation virtually eliminates breakdowns common in less reliable systems and also saves the cost of rushing repair personnel to remotely located stations.



The Pay-off!

In remote locations like this Columbia-Gulf Transmission Company station at Leach, Kentucky, it usually takes many hours to get repair personnel to the job in the event of breakdown. ElectroSyn reliability virtually eliminates the costs of both repair and downtime. Routine maintenance costs are slashed, too.

AMERICAN-Standard
DETROIT CONTROLS DIVISION



Humble Lubricants promote peak operating efficiency— longer engine life.

Humble produces a complete line of industrial oils for every lubrication need.

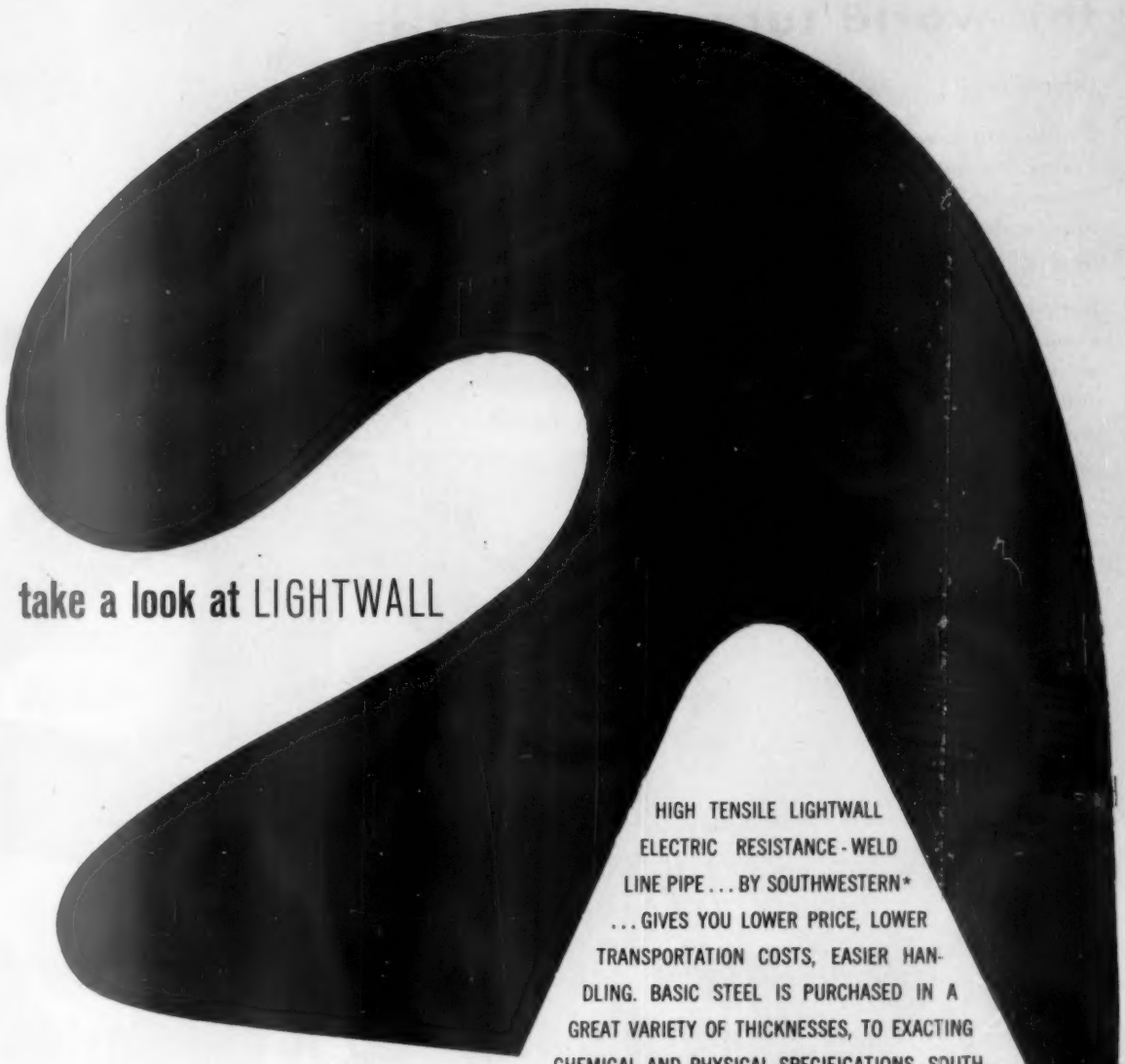
Humble industrial oils are produced from the best of crude stocks. These are carefully refined in Humble's great Baytown Refinery. Selected additives are blended in to give special qualities — detergency, rust and oxidation prevention, low pour point, increased film strength.

Humble industrial oils minimize engine deposits and reduce friction wear — allowing your engines to maintain peak operating efficiency and peak power output longer without costly down-time.

For complete information on Humble industrial lubricants see your Humble salesman, or phone or write: Humble Oil & Refining Company, Consumer Sales, P. O. Box 2180, Houston 1, Texas

At your request one of Humble's trained lubrication engineers will make a study of your lubrication needs and give you specific recommendations for a lubrication program tailored to your engines. This service is without cost or obligation.

HUMBLE OIL & REFINING COMPANY HUMBLE



take a look at LIGHTWALL

HIGH TENSILE LIGHTWALL ELECTRIC RESISTANCE-WELD LINE PIPE . . . BY SOUTHWESTERN* . . . GIVES YOU LOWER PRICE, LOWER TRANSPORTATION COSTS, EASIER HANDLING. BASIC STEEL IS PURCHASED IN A GREAT VARIETY OF THICKNESSES, TO EXACTING CHEMICAL AND PHYSICAL SPECIFICATIONS. SOUTHWESTERN'S* MILLS THEN FABRICATE THIS STEEL INTO MODERN LIGHTWALL ELECTRIC RESISTANCE-WELD LINE PIPE TO PROVIDE THE HIGHEST DEGREE OF EFFICIENCY AT THE LOWEST POSSIBLE COST. SOUTHWESTERN* PRODUCES LIGHTWALL PIPE FROM 1.315" O.D. TO 4.500" O.D. IN WALL THICKNESSES UP TO .188 WALL. YOU CAN DEPEND ON OUR PROMPT, RELIABLE DELIVERIES, DUE TO OUR FLEXIBILITY AND OUR LARGE INVENTORIES OF SELECTED STEEL COILS.

SOUTHWESTERN PIPE, INC.*

*Corporate name changed from Southern Sales & Transportation Co, May 1st, 1959

P. O. BOX 2002 HOUSTON 1, TEXAS PHONE CAPITOL 4-0631

LICENSED BY THE AMERICAN PETROLEUM INSTITUTE

the world turns on an idea

Simple idea... the wheel.

By turning it with water, man made it produce power.
Today we harness energy... and far more of it... by pipeline.
Through this great underground highway, natural gas is carried
thousands of miles. Lifted over mountains, forced under rivers
to give homes and industry heat and energy never available before.

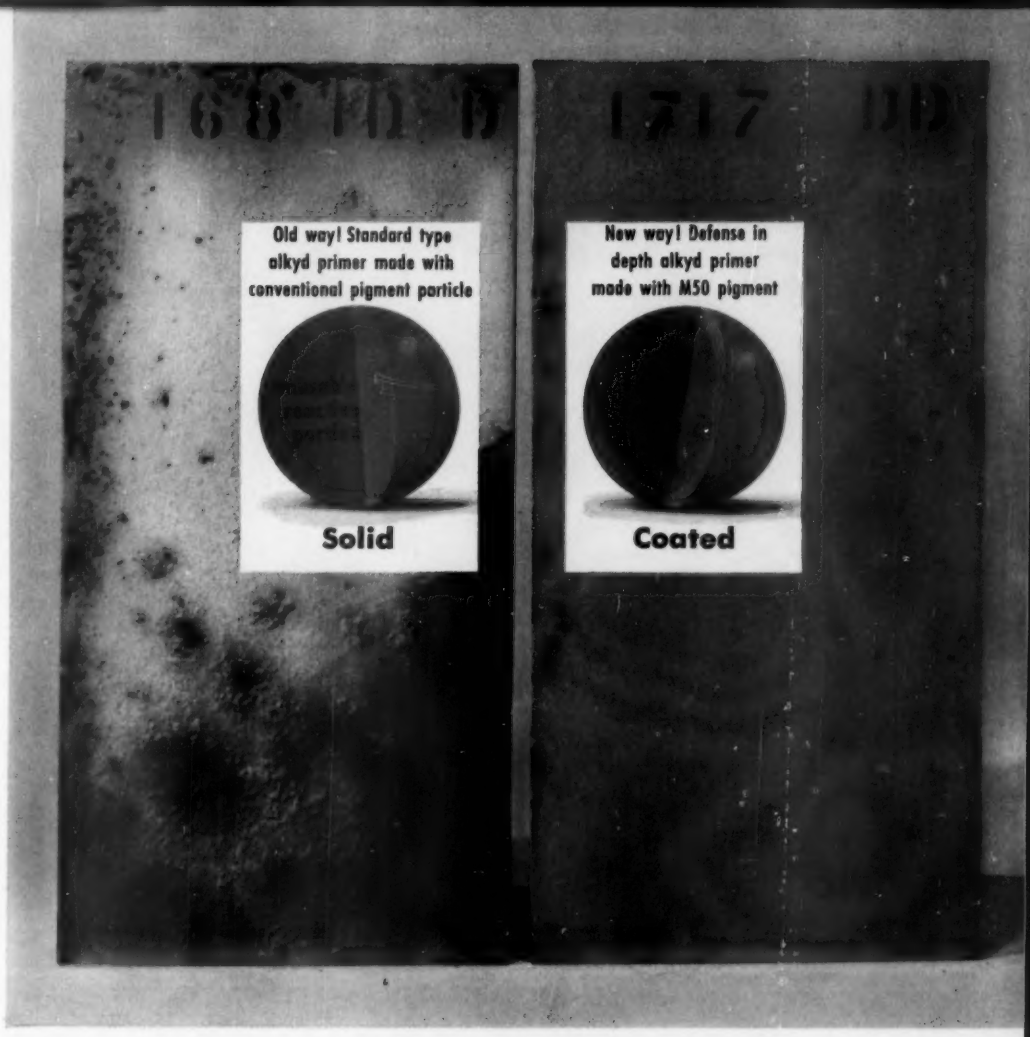
Simple idea... the pipeline. But typical of the many
great ideas and advances that have made
oil and gas the fast growing industry it is...
indispensable to the comfort and
well being of all Americans.

From natural gas and oil... heat, power, petrochemicals that mean ever wider service to man.

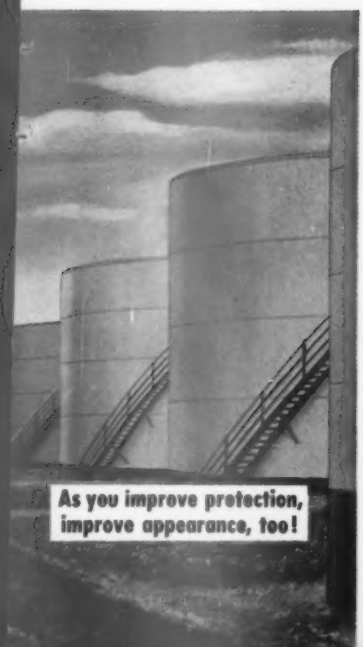
TENNESSEE GAS TRANSMISSION COMPANY
LEADING PROVIDER OF ENERGY—NATURAL GAS, OIL AND THEIR PRODUCTS
HOUSTON, TEXAS

DIVISIONS: Tennessee Gas Pipeline Company · Tennessee Gas and Oil Company · Bay Petroleum Company
SUBSIDIARIES: Midwestern Gas Transmission Company · Tennessee Life Insurance Company · AFFILIATE: Petro-Tex Chemical Corp.

Never before such durable tank protection


Old way! Standard type alkyd primer made with conventional pigment particle
Solid
New way! Defense in depth alkyd primer made with M50 pigment
Coated

Proof tank paints with M50® pigment form rust-inhibitive films of outstanding strength and durability



Test panels like these *prove* what paints can do. And these two make it plain that paints containing *M50* basic lead silico chromate — a new National Lead rust-inhibitive pigment ... form outstandingly strong and durable protective films.

Excepting the pigment, both primers shown on the test panels contain the same ingredients. Both are applied (2.0 mils, dry) on rusted and mill-scaled steel (to increase test's severity). Both have been exposed 12 months in industrial atmosphere (Perth Amboy, N. J.) and 12 months in normal atmosphere (Sayville, L. I.) at 45° South. You can see the effect.

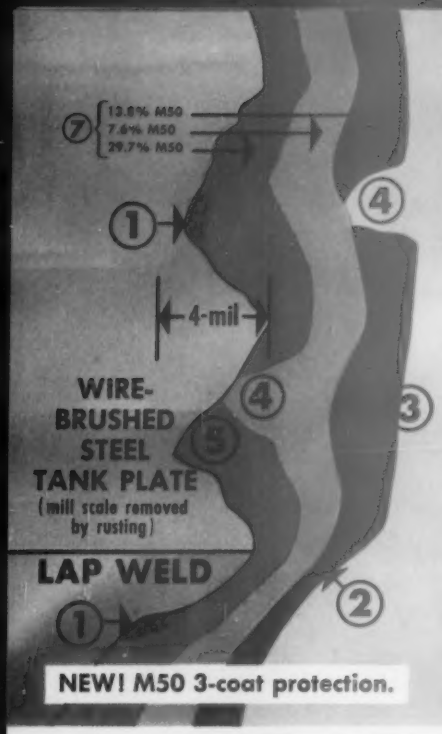
A striking difference! Yet film strengthening proves to be only one of many improvements that *M50* pigment makes in metal protective paints for steel tanks and structures. Now — with new *M50* pigment — your regular paint suppliers can provide metal protective paints with outstanding advantages:

- Weather-resistant anti-corrosive primers.
- Intermediate and finish paints *with* exceptional rust inhibition but *without* bilging hazard in sulfur-laden atmospheres.
- Finish paints in a wide range of decorative colors that don't fade or wash out.
- Alkyd-type conventional and heavy-coat paints with outstanding durability, package stability and sprayability.

What makes the difference? Basically the differences that make a difference in *M50* pigmented paints are inherent in the unique *M50* coated pigment particle itself (idealized particle shown above.) See, on the next page, the extra protections the *M50* particle provides in the dried film. See, too, how you can get the benefits of these new, much more durable, anti-corrosive paints.

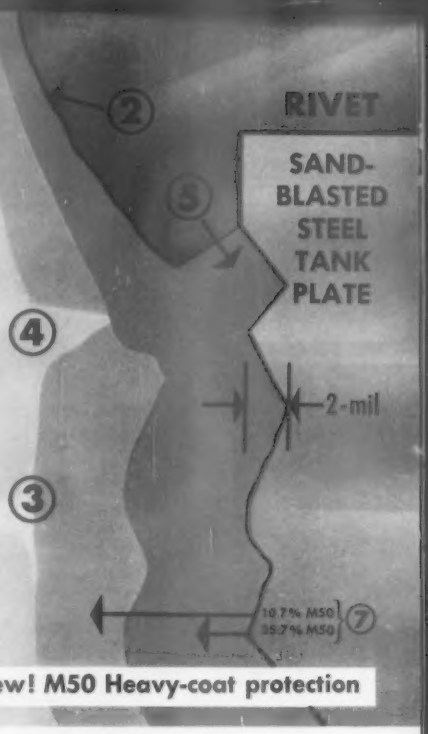
M50 pigment is a product of National Lead Company

General Offices: 111 Broadway • New York 6, N. Y.



NEW! M50 3-coat protection.

1. **Pockets of rust prove less harmful on steel** surfaces painted with conventional *M50* paints. Vehicles penetrate and isolate existing rust. *M50* particles stop rusting action.
2. **Where paint film lies thin** over tiny surface projections and sharp structural edges, the *rust-inhibitive* pigment content in all coats of *M50* paints provides extra protection.
3. **Just-right flow characteristics of** package-stable *M50* paints aid leveling on rough steel surfaces, promote smoothness, good appearance.
4. **Inevitable "holidays" in film** do not destroy protection. Again, *all M50* coats have both rust inhibition *and* weather resistance.
5. **M50 paints "wet" well,** penetrate pits and crevices, carry *M50* protection to every part of these danger spots.
6. **Lightweight M50 particle** aids formulation of new type heavy-coat paints with *uniform* rust inhibition throughout the film and low sag characteristics.
7. **Every coat can have rust inhibition** — not just the primer. Note percentages of *M50* in dry films. What's more, for equal weights of corrosion-inhibitive pigment, *M50* primers contain 40-60% more corrosion inhibition by volume than non-*M50* primers.



New! M50 Heavy-coat protection

Sections through M50 Defense in Depth films show dramatic extra protection these new tank paints provide

Information on the preceding page proves that *M50* pigment paints form stronger protective films than anti-corrosive paints made with other rust-inhibiting pigments. The sections above show some of the ways in which these new paints perform better in the dry film. Below you will see *proof* that *M50* metal protective paints don't bilge, are unique for color stability and the color range in which they can be made.

Hold the *M50* pigment particle itself responsible for all these improvements . . . *Basic lead chromate* is known for exceptional rust-inhibiting action. In the *M50* particle, this reactive business portion of the particle is coated on an inert core . . . where *all of it is available* to react. The coating is *fused* on—shows superior resistance to chalking, erosion, chemical action. Unusual tintability is due to the geometric configuration of the coated silica particle.

Why M50 Defense in Depth paints give anti-corrosion beyond all former concepts

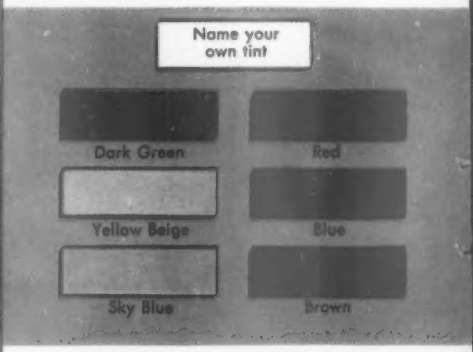
Gray Alkyd Finish Coat
2 standard pigment alkyd primer coats
1 standard pigment alkyd primer coat
2 M-50 pigment alkyd primer coats
1 M-50 pigment alkyd primer coat

Exposed 9 years, 45°S. Each coat 1.5 mils

Proved corrosion and weather resistance

Exposed 4 years adjacent to refinery

Proved anti-bilging performance



Available in conventional and heavy-coat paints

Proved stability in wide range of colors

Are you concerned with tank or structure maintenance painting in your firm? If so, you are invited: (1) to visit National Lead's Sayville, L.I. test station, where you will see the results of the 20 years research that lies behind the *M50* pigment particle and the more than 10 years of exposure testing that lies behind *M50* pigment Defense in Depth paints; (2) to send coupon below for National Lead booklet, "Defense in Depth" and typical *M50* tank paint specifications.

Next time you purchase, specify *M50* pigment paints. Any paint manufacturer can supply you.

M50 Defense in Depth

National Lead Company,
111 Broadway, New York 6, N. Y.

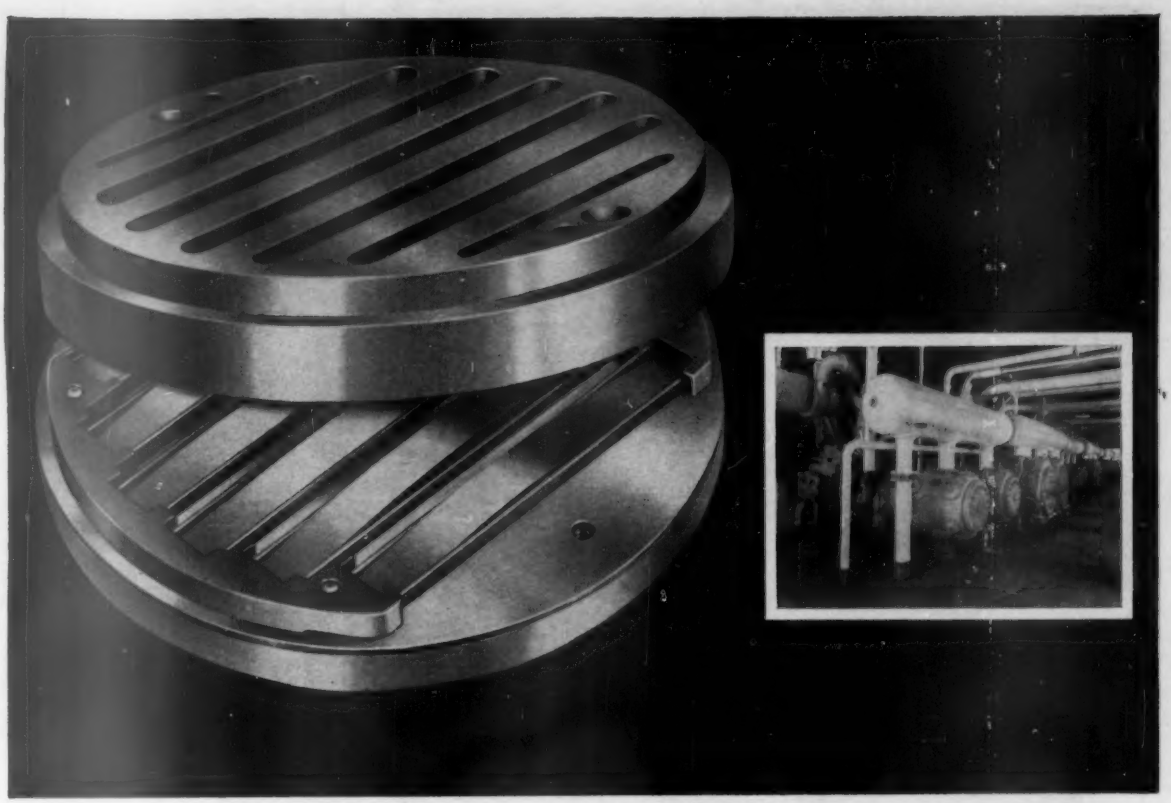
Gentlemen: Please send me the "Defense in Depth" booklet together with typical tank paint formulas and color chips that I can use in specifying M50-type tank paints.

Name_____ Title_____

Firm or Dept._____

Address_____

City_____ State_____



I-R Channel Valves at El Paso operate

43,000 HOURS *without a single replacement!*

At the Driver Station of El Paso Natural Gas Company, there are ten Ingersoll-Rand 2000-hp KVS gas-engine compressors, each with 56 Channel Valves. These compressors have been operating since New Year's Day of 1954, boosting about 100,000,000 cfd of gas from local tank batteries to El Paso's Midkiff gasoline plant seven miles away. Each KVS has operated more than 43,000 hours, and *not one Channel Valve has been replaced!*

Five valves have been cleaned due to foreign material sticking in them; this constitutes the only valve maintenance for a period of 5½ years, during which *each* of the 560 valves has opened and closed 850,000,000 times!

The secret of performance records like this is the patented I-R Channel Valve design; gas-cushioned action eliminates impact without using heavy parts that kill efficiency or flimsy elements which soon break or wear out. Each Channel Valve is a combination of straight-lifting stainless-steel channels and bowed leaf springs, with trapped-gas spaces which cushion action and prevent impact. The separate stainless-steel seat plate can easily be reversed or replaced for new life, so the valve seat never needs machining.

Performance like this is typical for Ingersoll-Rand equipment. All gas compressors, starting-air compressors, circulating pumps and the auxiliary power unit at the Driver Station are products of Ingersoll-Rand.

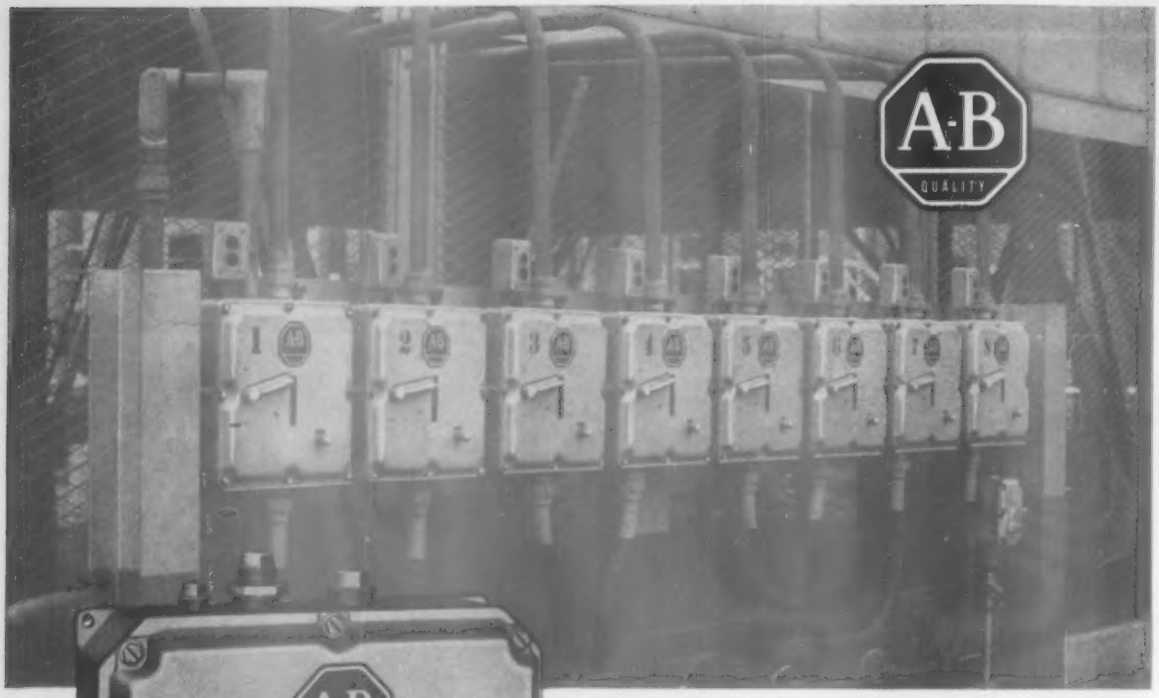
Only Ingersoll-Rand compressors have Channel Valves

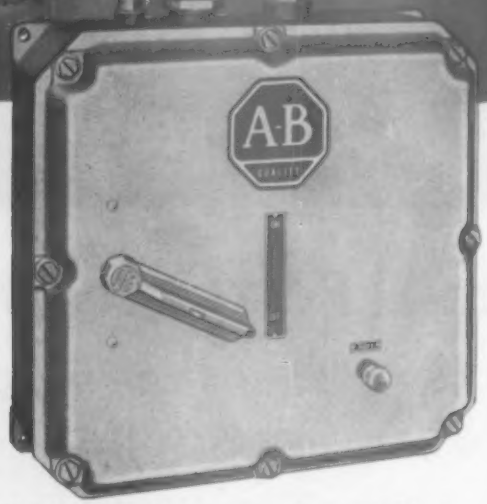
4-CYCLE

Ingersoll-Rand

Ad 6-968

11 Broadway, New York 4, N. Y.





Bulletin 713 Combination Starter with circuit breaker in NEMA Type 9 enclosure for hazardous dust locations.

NEMA 7
For Hazardous Gas Locations

NEMA 4
Watertight Weatherproof

NEMA 8
For Corrosive Hazardous Gas

NEMA 11
Corrosion-proof

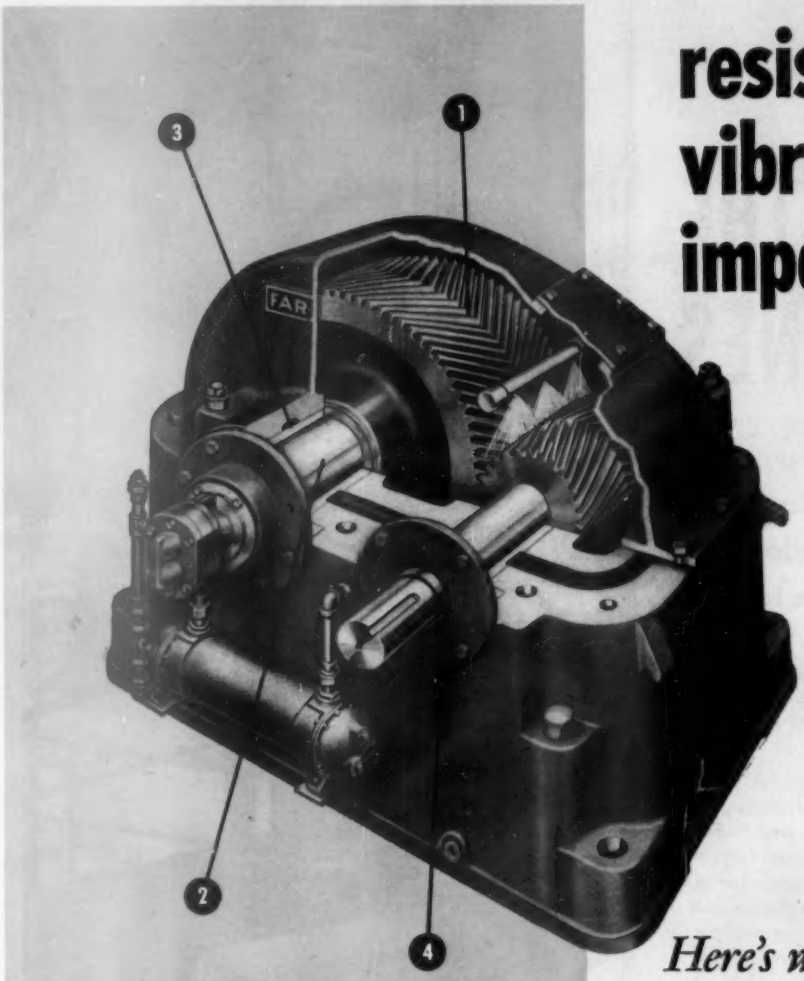
Round-the-clock safety . . . and reliability . . . without costly maintenance

When hazardous locations require starters in explosion-proof enclosures, it usually means costly maintenance. But *not* when you use A-B starters, because you eliminate the expense of removing and replacing bolted covers for "regular" inspection! In all A-B starters there is only ONE moving part. This is your assurance of *millions* of trouble free operations. There are no bearings to stick . . . no flexible jumpers to break. And the double break, silver alloy contacts never need servicing —they remain in perfect operating condition until completely worn away. The permanently accurate thermal overload relays are another "plus" feature. Insist on Allen-Bradley controls . . . and save on maintenance throughout the years.

ALLEN-BRADLEY
Quality Motor Control

Allen-Bradley Co., 1304 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

In speed increasers . . . look for



resistance to vibration and impact stresses

Here's why you'll find it when you come to **FARREL**

The problems involved in designing high-speed gearing are quite different from those encountered in ordinary industrial transmissions. Questions of vibration and impact stresses, for example, increase in importance as the speed goes up.

How the design of Farrel SI units has been tailored with these problems in mind, is described briefly at the right. For further details, send for a copy of bulletin 451.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N.Y.
Sales Offices: Ansonia, Buffalo, Boston, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Fayetteville (N.C.)
European Office: Piazza della Republica 32, Milano, Italy

Farrel-Birmingham

FB-1156

1 **Continuous-tooth herringbone gears** are generated with high precision by the famous Farrel-Sykes process. Gears and pinions are finish-machined on their shafts to insure concentricity of pitch diameters with axes of rotation. Teeth are lapped for a smooth working surface. Rotating elements are balanced for freedom from vibration at high speeds.

2 **Shafts are large** for the power to be transmitted, giving added stiffness against bending and torsional deflections under peak-loading variations. They are ground to a finished diameter with tolerances of plus .000", minus .001".

3 **Oversize bearings** have the capacity to shrug off shock loads. They are the precision-finished sleeve type, split, turned and bored...fitted to bored seats in the housing.

4 **Very sturdy housing** holds rotating elements in original alignment—preserves the operating smoothness of the precision-generated gearing.

HANDLING THE ROUGH ONES

Throughout the petroleum process industry, Reynolds Aluminum lowers installation and maintenance costs, serves longer.

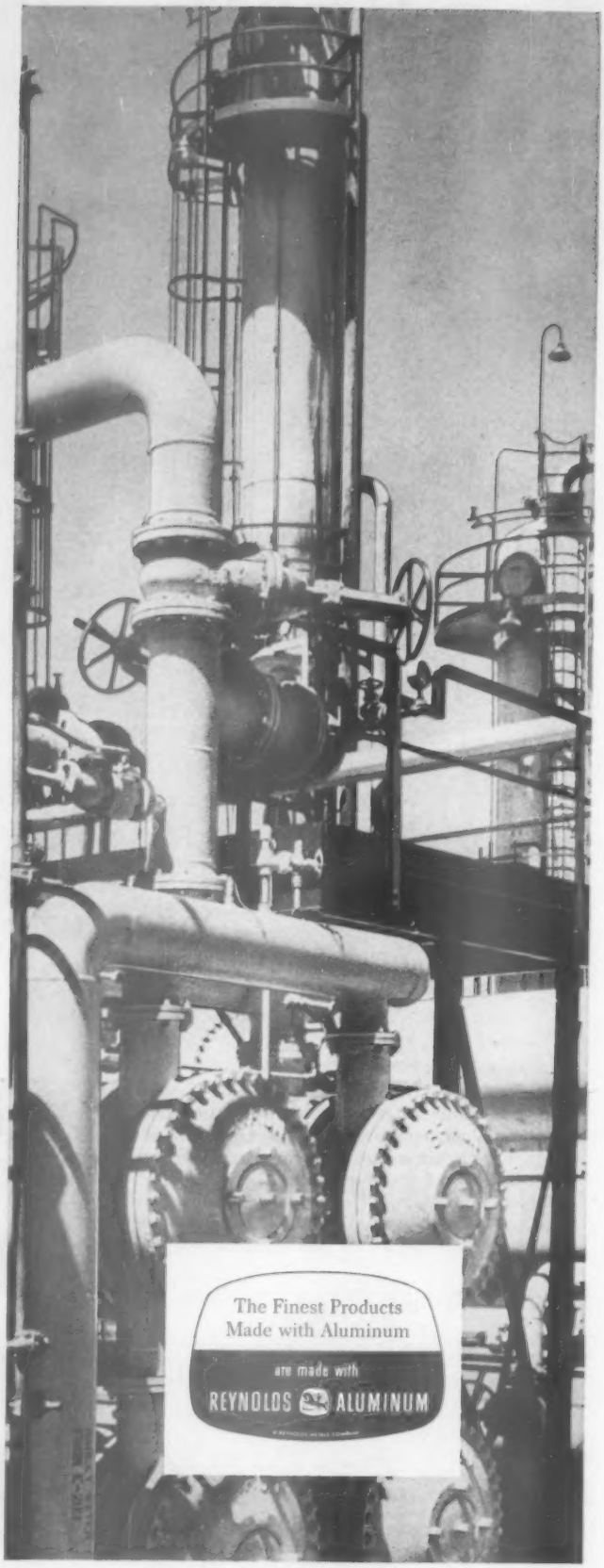
Wherever excessive corrosion, weight, maintenance and installation costs are factors, aluminum can probably do a better job at lower cost than any other metal.

A big statement, but there's plenty of proof in chemical processing plants, petroleum refineries, and oil fields all over the world. For example, aluminum needs no coatings to protect it from many corrosive atmospheres, liquids or gases. It keeps its strength and brightness even when handling materials that severely affect other metals. It is low in first cost and is one of the easiest materials to fabricate.

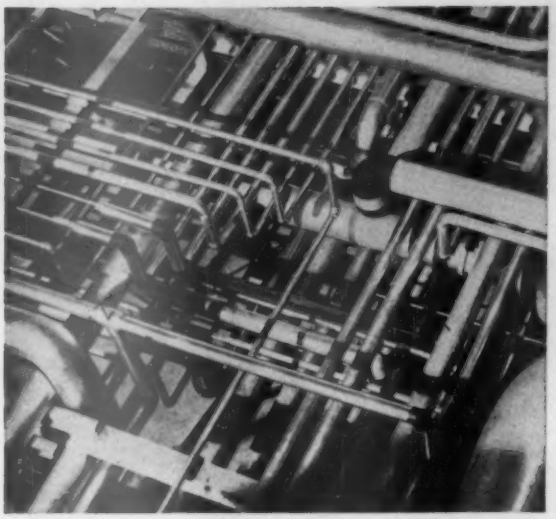
Because aluminum is light (one-third the weight of steel) it cuts handling and erection costs. And it's ideal for storage tanks and vessels that handle volatile fluids because it's (a) non-sparking, and (b) highly reflective.

For detailed information on specific properties or applications of cost-reducing aluminum for process installations, call on the people who know this metal best, Reynolds. Contact your local branch office, or write *Reynolds Metals Company, P.O. Box 2346-CR, Richmond 18, Va.*

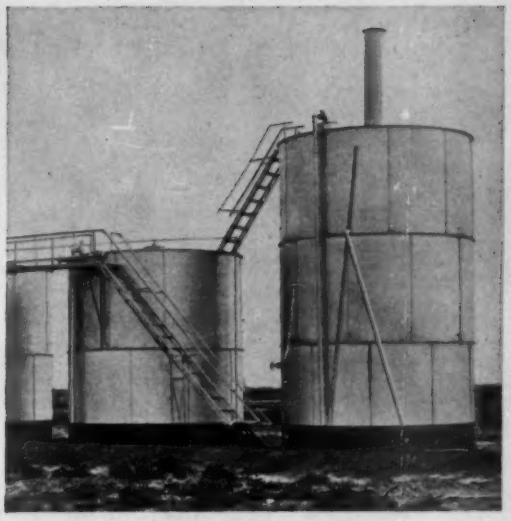
Watch Reynolds TV shows—"ALL STAR GOLF" and "ADVENTURES IN PARADISE"—ABC-TV



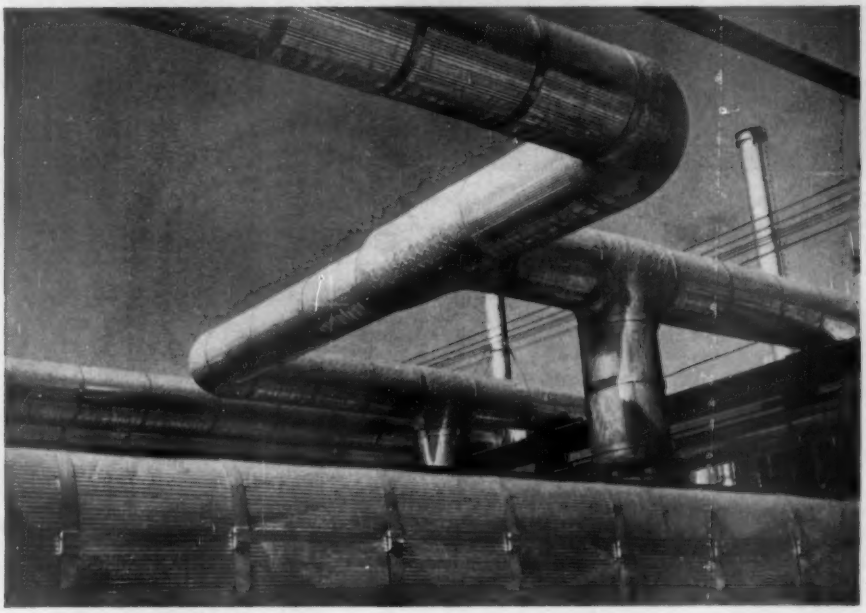
Reynolds Aluminum is a "natural" for lightweight, corrosion-resistant heat exchangers. It costs less than many other metals, has excellent heat transfer characteristics, resists fouling.



Reynolds Aluminum Process Pipeis easy and economical to install and requires minimum maintenance. It is widely used to handle corrosives like hydrogen peroxide, nitrogen solutions, refined products and many other corrosive fluids.



Aluminum Tanks and Vesselsrequire less maintenance, do a better job of protecting volatiles from heat. Aluminum resists corrosion, won't rust—and it reflects radiant heat.



Corrosion-resistant aluminum—ideal for jacketing. Non-sparking and highly reflective, it keeps volatiles cooler, safer, conserves heat . . . protects bulk insulation.

REYNOLDS ALUMINUM

Backfilling for Pacific Gas and Electric Co., near Hayward, California

JOHN DEERE cuts backfill time with "on the go" blade control

Complete one pass along the trench, and you can swing the blade as you turn for the clean up! That's one big reason operators like this easy-to-handle 64 All-Hydraulic Bulldozer.

Hydraulics control tilt, lift, and down pressure, too—right from the driver's seat. Direction reverser saves unnecessary shifting, cuts operator fatigue as well.

Diesel or Gasoline Power

You can get a John Deere 64 Bulldozer with either Diesel or gasoline power—whichever fits your needs—and all units can be financed confidentially through terms of the John Deere Credit Plan. For detailed information see your John Deere Industrial Dealer or write today.

John Deere Industrial Division, Dept. 1883, Moline, Illinois

John Deere Sideboom handles 4000 pounds 4 feet from boom pivot. Pipe bender attachment available.

Center-mounted or 5-position, new John Deere Backhoes dig to 13 feet, 6 inches.

JOHN DEERE *"Specialists in Low-Cost Power with a Heavyweight Punch"*

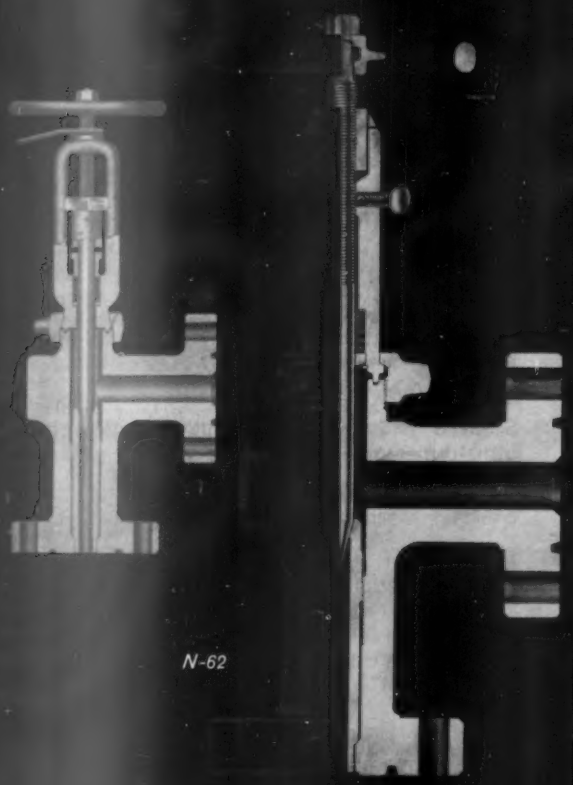
N-60

LESS TORQUE REQUIRED
FOR OPERATION

ADDED STABILITY
AND THUS LESS VIBRATION

NEW COMPACTNESS

AN ALL-NEW, SUPERIOR CHOKE LINE BY O·C·T



N-62

These are the characteristics that distinguish the new N-60 and N-62 adjustable chokes designed and produced by the Oil Center Tool Company.

Only a company with O-C-T's research in depth, its policy of staying abreast with oilfield needs, could improve on a good product—and that is exactly what was accomplished. The N-60 Threaded Adjustable Choke and N-62 Flanged Adjustable Choke replace O-C-T's time-tested Tee Type "N" and "N-2" Tee. The reason for replacement—a superior product.

The N-60 and N-62 are recommended for working pressures from 1500 to 5000 p.s.i.

On both flanged and threaded units, graduated indicators show the size of orifice in 64ths of an inch. Beans are quickly and easily changed. Proration tests can be made with both chokes by backing off yoke nuts and inserting proper size positive beans. All O-C-T wing nut connections have metal to metal and "O" ring seals.

The durable, compact and easily operated N-60 and N-62 Adjustable Chokes are available everywhere in supply stores. If you want additional information, check with an O-C-T representative. There is one near you.

where progress is a daily practice

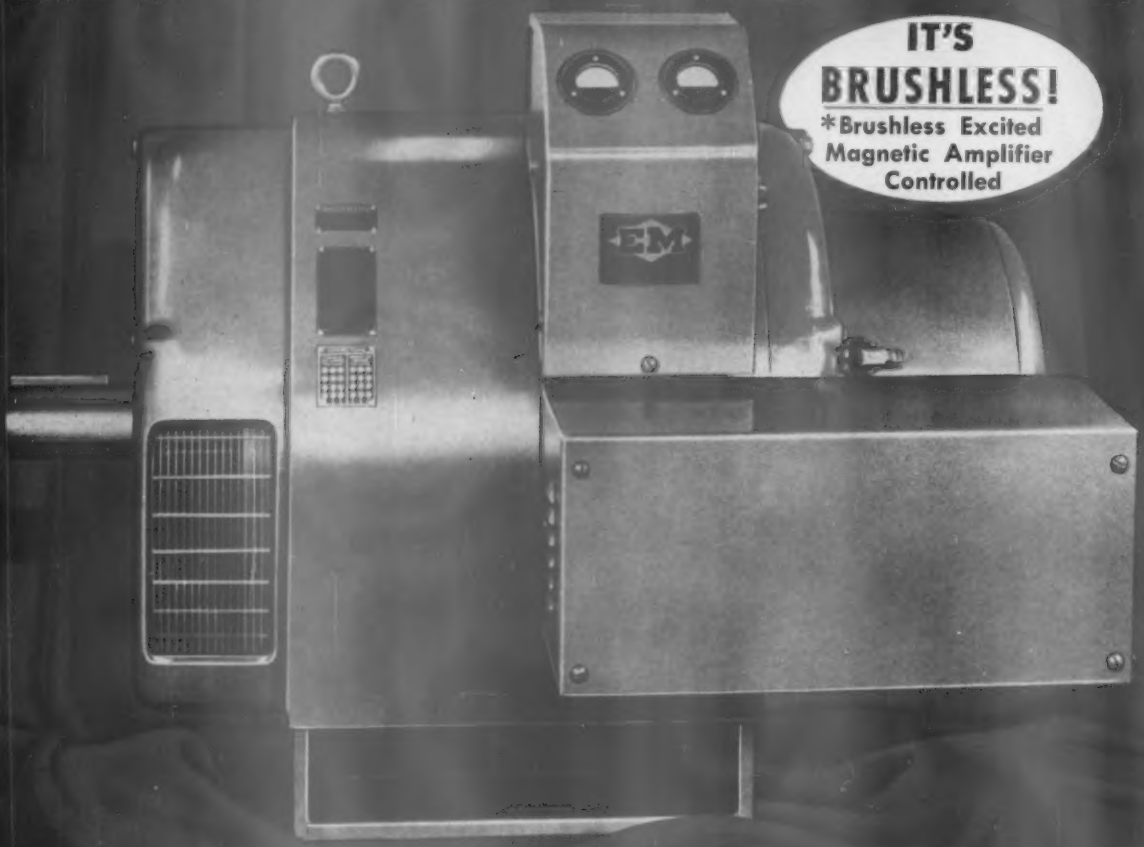
O·C·T

OIL CENTER TOOL CO.

SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Address Export Inquiries for All Countries to
P. O. Box 3091, Houston, Texas.

NOW for men who hate maintenance...
the NEW E-M BEMAC* Packaged Generator



RUGGED, RIGHT and READY with 10 BIG ADVANTAGES for you

1. **LICKS THE MAINTENANCE PROBLEM.** BEMAC has no commutator, no slip rings, no brushes! Requires no servicing other than an occasional bearing check.
2. **SAFER IN HAZARDOUS ATMOSPHERES.** No sparking contacts in the regulator or excitation system. Eliminates need for special enclosure on many applications.
3. **SIMPLE TO OPERATE.** No complicated servicing or adjustments — anyone can operate BEMAC.
4. **MAGNETIC AMPLIFIER "MAGIC"** automatically regulates voltage — a unique static voltage sensing circuit keeps the voltage "on the beam."
5. **POSITIVE VOLTAGE CONTROL** — easily set to help compensate for line voltage drop.
6. **"ROCK-STEADY" VOLTAGE** makes your motors, lights, and electronic equipment work better.
7. **BROAD-RANGE VOLTAGE** makes it simple to get the voltage you need . . . 120/208-139/240 and 240/416-277/480 volts.
8. **STARTS BIG MOTORS.** Built-in voltage boost transformer makes big motor starting easier.
9. **EASY TO INSTALL.** BEMAC is self-contained, completely factory assembled.
10. **BACKED BY 60 YEARS' EXPERIENCE** by the country's largest manufacturer of "Packaged" Generators . . . your best assurance of top quality performance and long life from every heavy-duty BEMAC "Packaged" Generator.

ELECTRIC MACHINERY

The finest in "Packaged" Generators

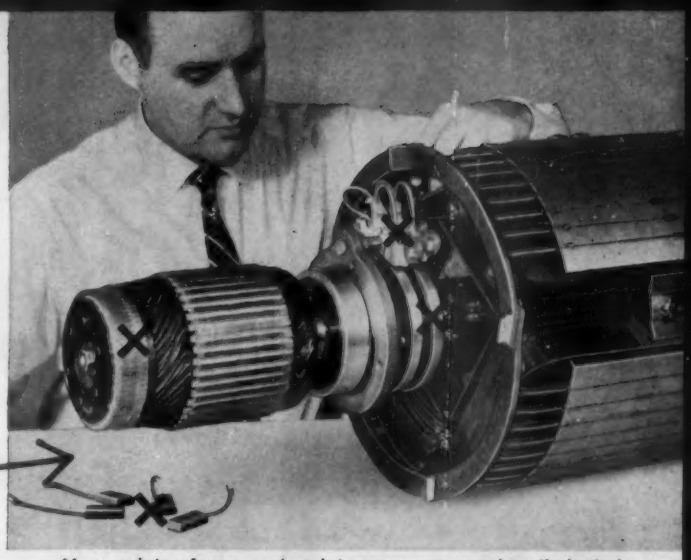
NO COMMUTATOR
NO SLIP RINGS, NO BRUSHES

BEMAC is better suited for corrosive, dusty, and hazardous atmospheres

Conventional generators receive D-C excitation from exciters thru commutator, slip rings, and brushes. In BEMAC these parts are replaced by static silicon rectifiers.

LOOK WHAT HAPPENED TO MAINTENANCE...

WHEN WE SUBSTITUTED AGELESS SILICON RECTIFIERS



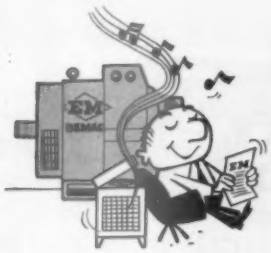
Many points of wear and maintenance now can be eliminated.

A.C. to D.C. rectification is made with reliable, efficient silicon diodes.

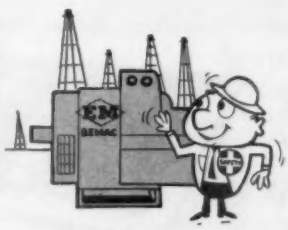
There are no moving electrical contacts — sparking is eliminated. There are no electrical parts subject to wear and damage from dust and dirt — you have highest operating reliability.

Your E-M Field Engineer will be glad to give you more information on E-M BEMAC "Packaged" Generators equipped with automatic static voltage regulators. BEMAC is available in ratings of 10 thru 150 kw, 3 phase; 10 thru 100 kw, 1 phase; 1200 and 1800 rpm; 0.8 PF; 60 cycle; 120/208-139/240 and 240/416-277/480 volts, 3 phase; 120/240 volts, 1 phase.

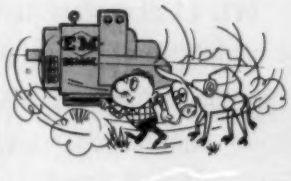
● **New Literature:** Write factory for your copy of publication No. 255. It tells how BEMAC works.



LESS RADIO INTERFERENCE



SAFER IN HAZARDOUS ATMOSPHERES



MORE DUST RESISTANT

LESS AFFECTED BY CORROSION

MFG. COMPANY MINNEAPOLIS 13, MINNESOTA

from the Originators of "Packaged" Generators

TAKE YOUR PICK OF PERFECT PACKERS

202
SCREW-THRU
PACKER
Most popular packer used for sealing screen and liner to well casing and cementing blank liner in casing.
202
SCREW-THRU
SETTING TOOL
For setting Packer 202, blank liners and for cementing liners. Simplest, most foolproof on the market. Rotates to right. No picking up for release. All movements downward.
204
TYPE "TS"
PACKER
Primarily to set with tubing. Same as Packer 202 except it has only 36" of canvas and sets with sleeve down—canvas up. Graveling Packer 205 (not shown) used in gravel packs only. Operates same as Packer 204 except for top left hand threads and 8' of canvas.
207
TYPE "TS"
COLLAPSING
TOOL
Used on tubing string with "TS" Letting In Tool 308. Located inside packer stem above letting in tool.
223
ANCHOR
PACKER
Most popular with gravel pack settings. Serves as both liner and production packer. No slips, choice of 3 seals. Works with all types screw-liner completions. Simple field repairs.

Well completion products and gravel packing services for over a half century have merited the confidence of the industry.

For fast, dependable answers to your production problems, call or write P. O. Box 1327, Houston 1, Texas, ORchard 2-7561.

THE LAYNE

THE LAYNE AND BOWLER COMPANY

new..

"Varec" Dynamatic

HIGH ACCURACY AT LOW COST

Power Operated

liquid level

TANK GAUGE

- Accurate to better than 1/16".
- Readings in feet inches and sixteenths.
- Graduations available in metric and decimal.
- No floats, counterweights or spring balances.
- Large, easy to read numbers on dial and counter.

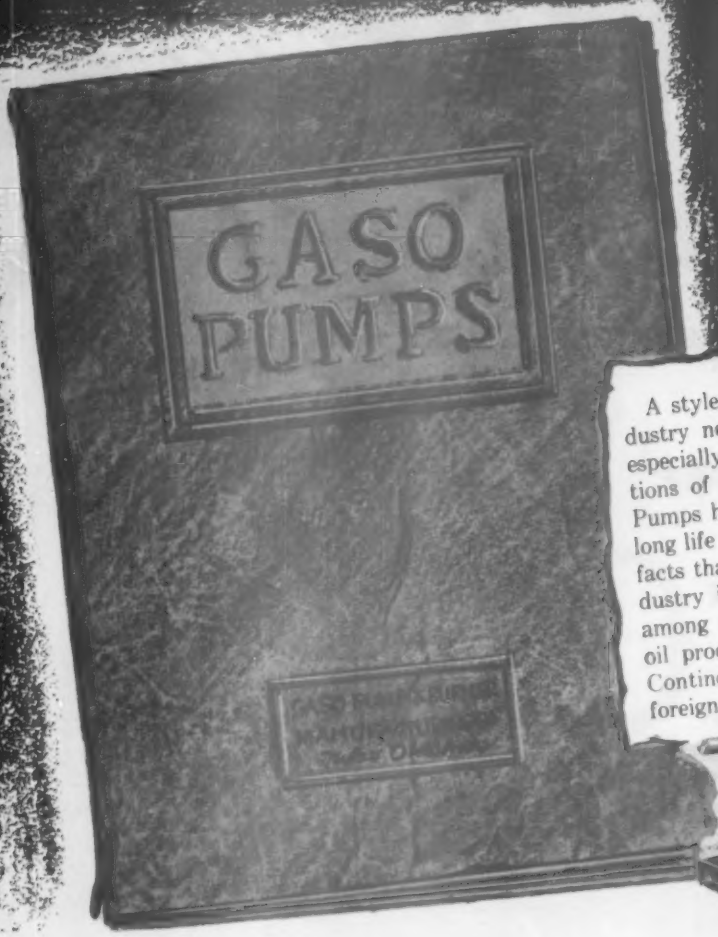
The *Dynamatic* Power Operated Gauge utilizes a force balance system arranged to detect and display liquid level. The measuring device consists of two elements; a force measuring element and a displacer that is a solid plate of any material suitable to the environmental conditions.

Friction—the specific gravity of the product— the load placed on the gauge head to drive accessory controls and remotes—turbulence—none of these have any adverse effect on the accuracy or reliability of the gauge.

The remarkable low cost and the high level of accuracy and sensitivity have been achieved by Varec's uniqueness of design and not by the sacrifice of quality materials and workmanship. ● *Request Bulletin CP-3705* ●

The Vapor Recovery Systems Company — Compton, Calif.

PUBLISHED 34 YEARS AGO ..Still True



A style of pump is offered to meet every Oil Industry need, and every item in our line has been especially designed to withstand the severe conditions of oil field and refinery service. That Gaso Pumps have met the tests of unflinching operation, long life and low maintenance cost is attested by the facts that over 12,000 have been sold to the Oil Industry in the past ten years and that we number among our customers practically all of the leading oil producing and refining companies in the Mid-Continent, as well as many in other domestic and foreign oil fields.

It is a far cry from this catalog, published 34 years ago, to our latest catalog, recently released. Today's Gaso line includes models to meet every need and condition within the capacity range of the pumps. Today's Gaso Pumps embody metals and design principles unknown in 1925.

But the story told in the foreword—a story of leadership and how it is maintained—is as true today as when it was first presented, 34 years ago.

Have you a copy of our latest catalog? If not, we'll be happy to send you one.

DISTRIBUTORS:

Farmington, N.M.—Gaso Pump & Burner Mfg. Co.
Shreveport, La.—W. L. Somner Co.
Odessa, Texas—W. L. Somner Co.
Brookhaven, Miss.—W. L. Somner Co.
Tinsley, Miss—W. L. Somner Co.
Hobbs, N.M.—W. L. Somner Co.
Houston, Texas—Texas Pump & Compressor Company.
Wichita Falls, Texas—Pump Engineering Co.
Evansville, Indiana—Hague Equipment Co., Inc.
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Edmonton, Alberta, Canada—Lufkin Machine Co., Ltd.

GASO PUMP & BURNER MFG. CO., 901 EAST FIRST ST., TULSA, OKLA.
EXPORT OFFICE: EMPIRE STATE BUILDING, NEW YORK, NEW YORK

GASO PUMPS
for every oil industry need

100th Anniversary of Oil in America 1959 **44th Anniversary of Gaso Leadership**

GET GASO DEPENDABILITY IN WATER FLOODING, TOO

Gaso Pumps in operation at a water flooding pilot plant in Venezuela

The same time-tested characteristics that established Gaso Pumps as leaders in pipe line service have made them the outstanding choice in water flooding service. More service per pound of weight or dollar of cost. Longer life with less maintenance. Rugged compactness. Above all, the assurance of dependable performance, with types and sizes that assure adaptability to the job.

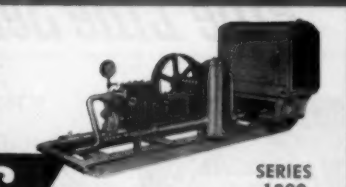
Gaso distributors are qualified by training and experience to help you find the effective answer to any problem associated with water flood service. You will find them listed on the opposite page. Latest catalog on request.

SERIES 3600

Horizontal Triplex Plunger Pumps with 6" stroke and either of two fluid ends. The large capacity fluid end (Fig. 3671) takes 2½" to 3½" plungers and operates with pressures from 1575 to 800 psi. Small fluid end (Fig. 3670) takes 1½" to 2¼" plungers and operates with pressures from 3750 to 1935 psi.

SERIES 3300

2¼" x 3" Horizontal Triplex Plunger Pump designed for rugged, high-pressure service. Extraordinary performance (up to 44 Bbls. per Hr.), time-tested Gaso design features in a pump that weighs only 720 pounds.



SERIES 1800

Fig. 1849 takes 2½" to 4" pistons and operates with pressures from 900 to 350 psi. Fig. 1847 takes 2½" to 4½" pistons and operates with working pressures from 900 to 275 psi.

GASO PUMPS
for every oil industry need

CAREFUL STUDY DICTATES CHOICE OF PUMPS

GUESSWORK AND HUNCHES OUT IN PRESENT-DAY BUYING PRACTICE

Guesswork, hunches, even personal preferences, have no place in the present-day selection of pumps for pipe line, water flooding and other projects.

Today efficiency-conscious management insists on the selection of pumps which, through investigation, prove to measure up in greatest degree to the concept of maximum performance per dollar expended.

These facts were brought out in a study of recent sales by Gaso Pump & Burner Manufacturing Co. Among the yardsticks used to govern pump selection are:

Completeness of line, assuring models and types best suited to specific conditions.

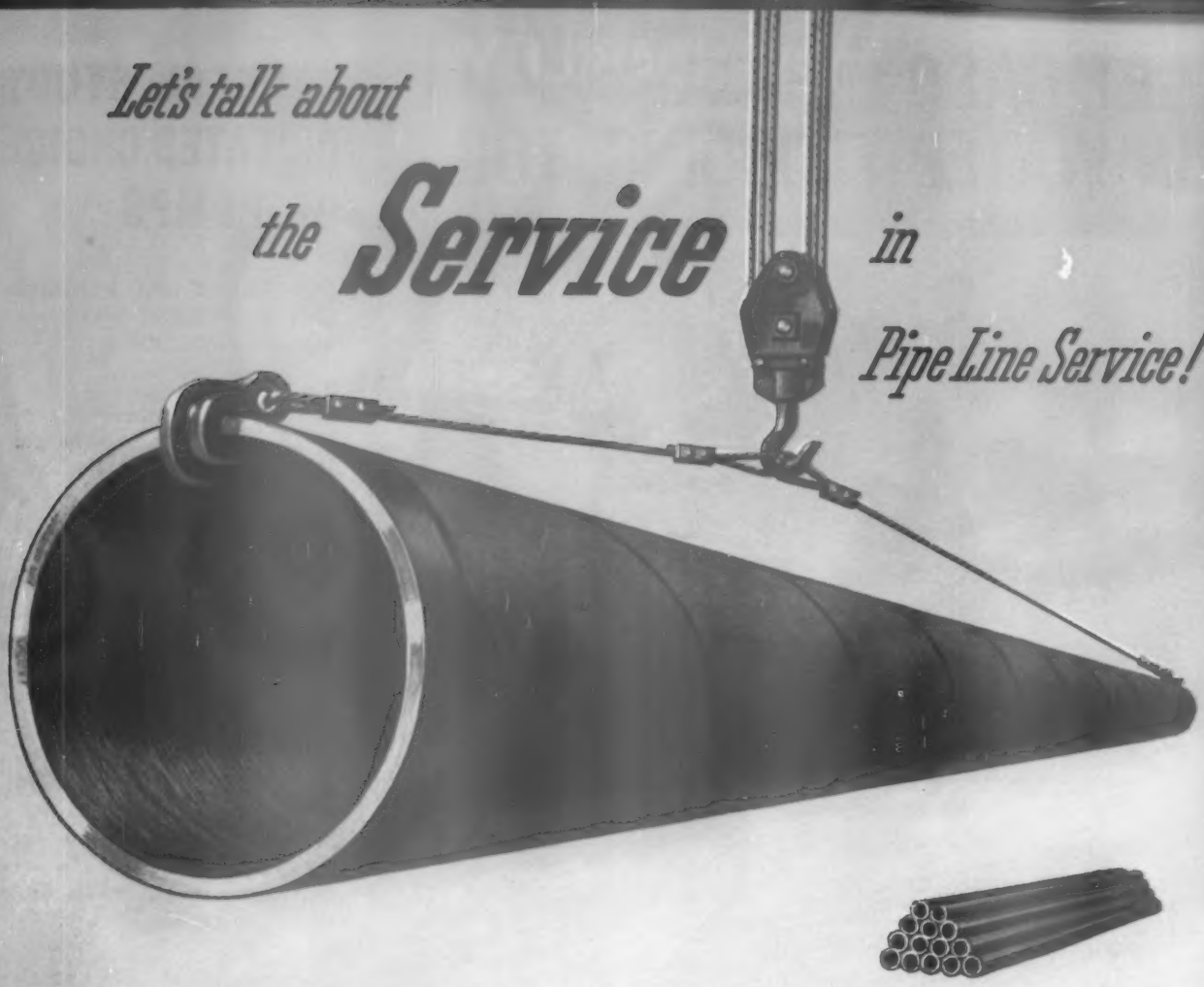
Performance record, embracing a study of service, service life, operating and maintenance costs.

Responsibility of manufacturer.

Follow-Through Service, with special emphasis on the availability and immediate delivery of parts.

For the Gaso company, selection based on investigation is a welcome practice. Any study by prospective customers will reveal a complete line of pumps in the Gaso capacity range, with a 44-year record of dependable, economical performance. Significantly, parts are still available for any standard model ever built by Gaso—with service calls which indicate that many of its earliest models are still in operation.

Let's talk about the **Service** *in Pipe Line Service!*



A company doesn't become a leader through quality of product alone. Although Pipe Line Service through the years has proved consistently that quality depends on coating and wrapping under controlled plant conditions, *service* is half the battle.

By service, we mean storing your pipe at plants strategically located near your sources of supply . . . and large storage facilities to allow you to purchase pipe when delivery is most favorable. Your pipe will be held in storage until needed—and then coated under the PLS high standards of uniformity. You *always* get a freshly applied coating job at the time pipe is ready to be laid. And PLS will ship your protected pipe *where* you want it . . . *when* you want it!

All this, *plus* the service of a PLS representative when needed. It's his job to help you in the proper handling, storage and laying of PLS protected pipe, to give you the maximum return on your investment.

This combination of quality *and* service assures you of the finest in pipe protection. On your next coating job call in your nearest PLS representative—you'll find that he can save you time, trouble and money.

There's a PLS plant strategically located to serve YOU!

Also sales offices at
Atlanta, Georgia — Lincoln, Nebraska
Tulsa, Oklahoma — Houston, Texas
Syracuse, New York

PIPE LINE SERVICE CORP. SERVICE COMPANION MATERIALS FRANKLIN PARK, ILL.

Pipe Line Service Corporation

FRANKLIN PARK, ILLINOIS

Quality pioneers in coating and wrapping pipe for a quarter century

A SUBSIDIARY OF AMERICAN STEEL FOUNDRIES

RIGID PLASTIC PIPE made of

CYCOLAC®

THE TOUGH, HARD **ABS** PLASTIC
from BORG-WARNER

OUT-PERFORMS CONVENTIONAL PIPE IN VITAL OIL FIELD APPLICATIONS!

Ideal for salt water well tubing, for salt water gathering and disposal lines • Safely carries sour crude • Serves as fresh water lines on leases • Handles water flooding jobs

No other pipe combines so many benefits in terms of installation, performance, long-term economy! That's because no other material is exactly like Cycolac — the new standard for quality in the plastics field. Pipe made of Cycolac has been thoroughly proved in use . . . in the oil fields.

Write for the name of your nearest supplier

10 Reasons why you're right with Rigid Pipe made of CYCOLAC!

1. **LIGHTWEIGHT.** Easy to carry — approximately ⅛ the weight of comparable iron.
2. **RUSTPROOF, ROTPROOF.** Unharmed by soil acids — never corrodes or scales.
3. **CHEMICALLY RESISTANT.** Carries waste, salt solutions, organics with wet corrosives.
4. **HARD AND TOUGH — SUPERIOR TENSILE STRENGTH.** Excellent burst-resistance, even at high temperatures.
5. **LOW FRICTION LOSS.** Mirror-smooth interior surfaces insures higher rate of flow.
6. **VERSATILE.** Used for process piping — water systems — natural gas — electrical conduit.
7. **NON-TOXIC.** Approved for potable water by the National Sanitation Foundation.
8. **EASILY JOINED WITH METAL.** Used to replace corroded sections or to line metal pipe.
9. **EASY TO INSTALL.** Quickly jointed — less ditching — no costly handling equipment.
10. **LOW IN COST.** Less than most metal or plastic pipe — greater serviceability.

PACESETTER IN
Marbon CHEMICAL
SYNTHETIC RESINS

Division of BORG-WARNER • Washington, W. Va.

also represented by:
WEST COAST: Harwick Standard Chemical Co., Los Angeles, Cal.
CANADA: Dillons Chemical Co. Ltd., Montreal & Toronto
EXPORT: British Anchor Chemical Corp., New York

BW® Marbon

ENGINE SPECIALISTS—Milt Walker, Al Busch and Frank Carter—will visit every Worthington engine compressor pipeline installation once every six months. Shown on the map are the major natural gas pipelines.

VISIT EVERY PIPELINE ENGINE

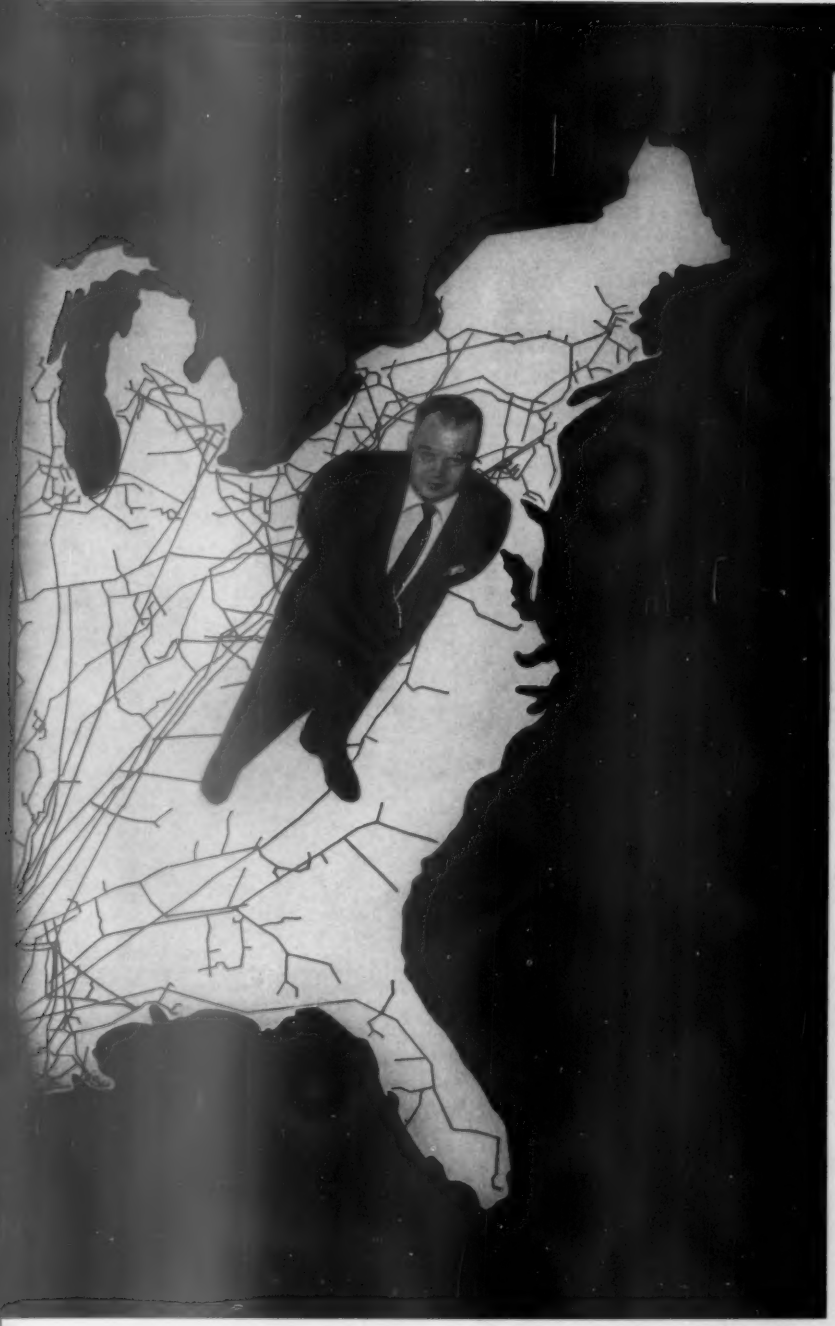
That's the schedule of Worthington's new missionary organization for pipeline engine compressors

Worthington has had a missionary program for engines and engine compressors for many years.

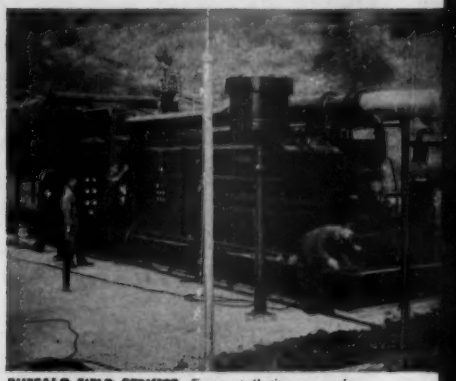
In order to give special attention to vital pipeline installations, however, Worthington now has a program for visiting every pipeline engine compressor at least once every six months.

Three key Worthington engine compressor specialists, Milt Walker, Al Busch and Frank Carter, have been assigned to this important project. In their visits they will . . .

1. **Assist operators** in all phases of engine compressor operation and maintenance.
2. **Observe practices** in current use at each installation.
3. **Set up or modernize procedures,** based on the latest methods and practices.
4. **Submit reports** to pipeline companies giving station-by-station commentary



REGIONAL ENGINEERING & SERVICE. For routine service or emergency help, Worthington R. E. & S. personnel are available on a moment's notice.



BUFFALO FIELD SERVICE. For installation or major repairs, Worthington maintains a cadre of experienced engine personnel in Buffalo.

REGIONAL PARTS SERVICE. Large stocks of pipeline engine parts are maintained in Buffalo, Houston, Los Angeles, Calgary and Colombia, South America.

NEW SERVICE MINDED SALES ORGANIZATION. Sales and service are now combined in an organization that is more responsive to your service needs.

EVERY 6 MONTHS!

about the practices observed plus specific suggestions for future consideration.

This Worthington service is another progressive step taken by a service-minded company. Other steps include (1) Regional Engineering and Service—nearby, quickly available help on a decentralized basis, (2) Factory Field Service—a centralized pool of engine compressor specialists for installation and for major service problems, and (3) Regional Parts Service—depots of engine compressor parts are maintained in Buffalo, Houston, Los Angeles, and Calgary in North America, and in Colombia, South America. Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) Ltd., Brantford, Ontario. A3-5

WORTHINGTON

STILL ANOTHER FIRST –

World's largest positive displacement meter!

BRODIE
B-142 *BiRotor*
METER

GIANT CAPACITY

- 20,000 barrels per hour
- 150 psi — maximum working pressure

RUGGEDLY BUILT FOR HIGH PRECISION

This huge capacity new Brodie B-142 *BiRotor* was designed to measure crude and refined products. Its high precision and sustained accuracy insures dependable continuous operation under rugged conditions. Skillfully engineered by experienced meter craftsmen the B-142 employs the outstanding Brodie *BiRotor* metering principle.

There's a Brodie Meter to meet your every requirement in petroleum metering. For the solution to your metering needs, call your nearby Brodie Specialist.

911

RALPH N. BRODIE COMPANY
San Leandro, California, U.S.A.
CABLE ADDRESS: "BRODICO"

MT. VERNON, N.Y., 550 So. Columbus Ave.
DALLAS 7, TEXAS, 167 Parkhouse St.
SEATTLE 9, WASH., 221-9th Ave. N.
CHICAGO OFFICE: 1227 Circle Ave., Forest Park, Ill.
LOS ANGELES 22, CALIF., 5401 Sheila Street

BRODIE
BiRotor METERS

REPRESENTATIVES WITH STOCKS AND SERVICE FACILITIES IN ALL PRINCIPAL CITIES

Men who know pipe point to
WHEATLAND

for EASY THREADING

INSIST ON PIPE MADE IN U. S. A.

Steel pipe that cuts and threads easily and evenly—Wheatland Steel Pipe—is singled out by more *knowing* men every day. They know that Wheatland Pipe saves them time, minimizes wear on tools and reduces labor fatigue. Every length is backed by Wheatland's sincere desire for complete customer satisfaction. Next time, point to Wheatland!

...pipe with the yearmark!

API LINE PIPE IN ACCORDANCE WITH AMERICAN PETROLEUM INSTITUTE SPECIFICATIONS

WHEATLAND - 59

For Black or Galvanized Pipe, contact your distributor or

WHEATLAND TUBE CO.

BANKERS SECURITIES BUILDING, PHILA. 7, PA. • MILLS: WHEATLAND, PA. • DELAIR, N. J.

2 BIG REASONS WHY MAJOR PIPELINES

1 LOW MAINTENANCE. Bingham Pipeline Pumps are of "Double Volute" design, insuring perfect hydraulic radial balance of rotating element. "Hydraulic Radial Balance" eliminates unequal pressures on the rotating element—**"Side Push"**—which is the primary cause of wear and maintenance in conventional pumps. Also this feature, which eliminates shaft deflection, permits **mechanical seals** to establish and maintain uniform track between the contacting faces. This prevents leakage and seal face wear, resulting in *long seal life.*

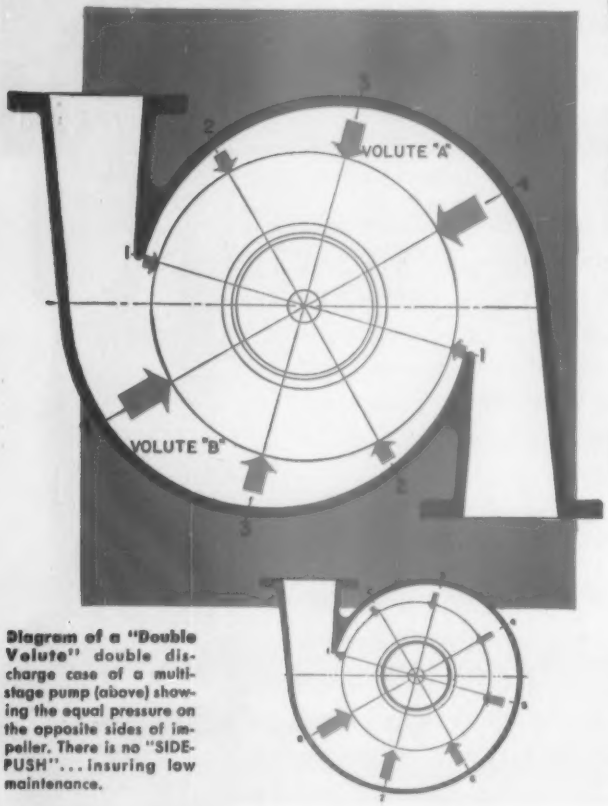
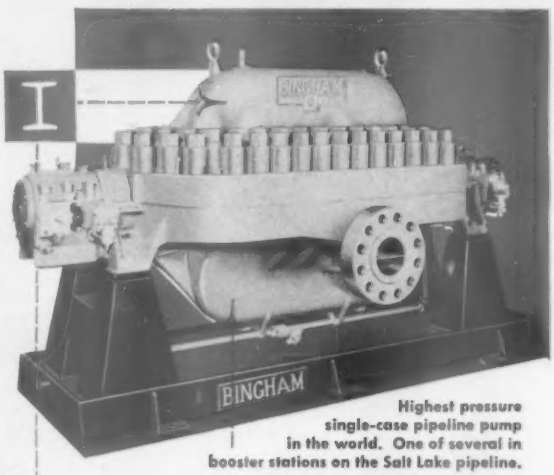


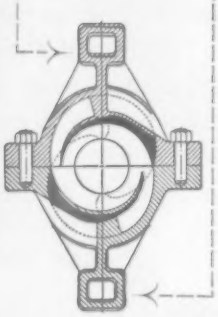
Diagram of a "Double Volute" double discharge case of a multi-stage pump (above) showing the equal pressure on the opposite sides of impeller. There is no "SIDE-PUSH"... insuring low maintenance.

Diagram of "Single Volute" pump case (immediately above) showing unequal pressures at opposite points around the periphery of the impeller. These unequal pressures cause "SIDE-PUSH" on the rotating elements, causing wear of rotating parts and, frequently, high maintenance.

2 ASSURED CASE STRENGTH FOR HIGH-PRESSURE SERVICE



Highest pressure single-case pipeline pump in the world. One of several in booster stations on the Salt Lake pipeline.



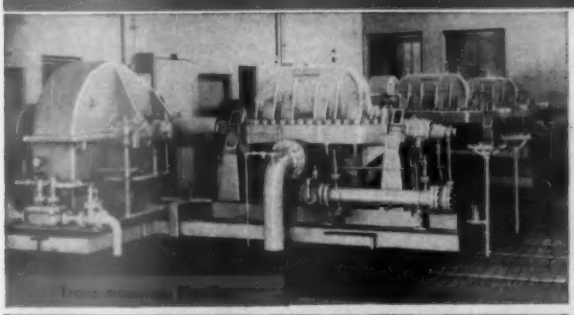
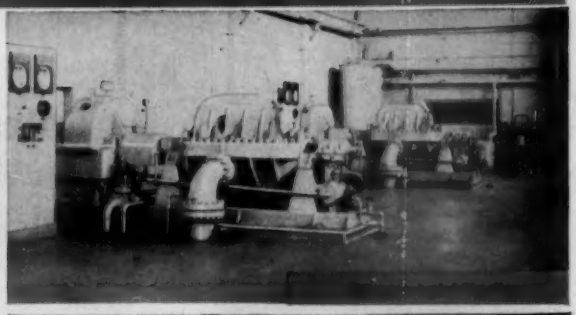
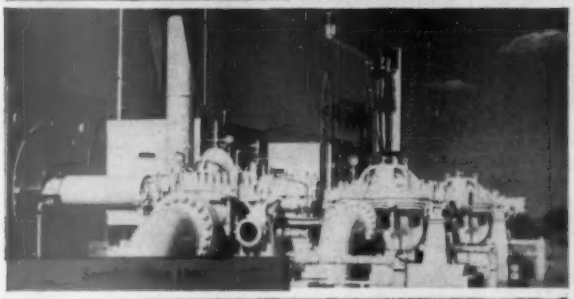
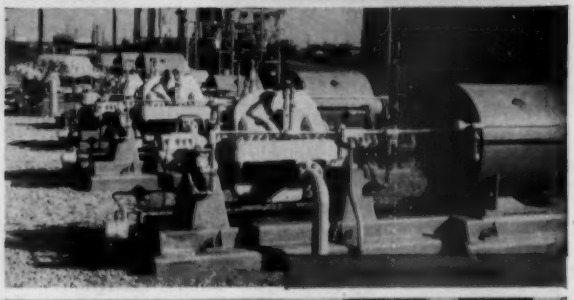
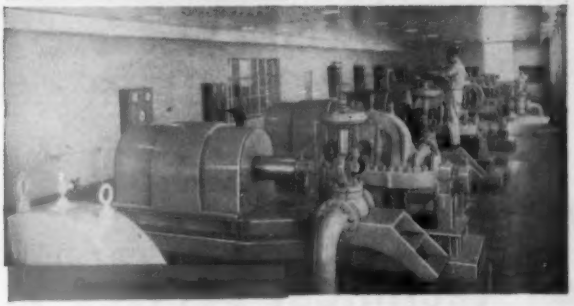
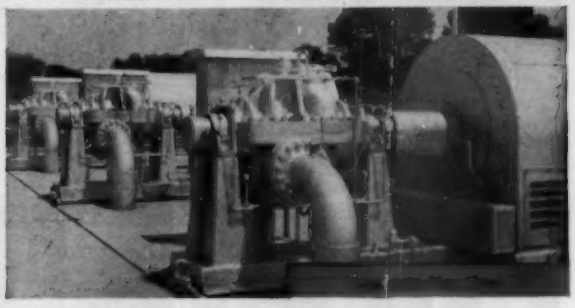
Transverse cross-section diagram of a Bingham "Double Volute" Multi-Stage Pump, showing identical cross-overs cast integrally with the upper and lower halves of the pump casing.

Integral cross-overs in Bingham "Double Volute" multi-stage pumps produce casings of maximum strength for high pressure service because each cross-over is cast integrally with its half of the pump casing, and thereby becomes a structural member of Bingham's "I-Beam Truss Construction".

This feature, found only in Bingham pumps, increases the strength of the pump casing to such an extent that it can safely withstand operating pressures up to 2000 psi with standard construction (higher pressures with special construction).

Bingham "Double Volute" Multi-Stage Pumps will best serve your pipeline operations, as they are now serving major pipelines. Write to your nearest Bingham office for "Double Volute" Bulletin or additional information.

SELECT *Bingham*
. . . "DOUBLE VOLUTE" PUMPS

PARTIAL LIST OF MAJOR PIPELINES WITH BINGHAM "DOUBLE VOLUTE" PUMPS IN OPERATION OR ON ORDER

Ashland Oil Pipe Line
Buckeye Pipeline
Badger Pipeline
Cities Service Pipeline
Continental Pipeline
Esso Standard Oil Pipeline
Getty Oil Company
El Paso Natural Gas Prod. Co.
Everglades Pipe Line Co.
Great Lakes Pipeline
Interprovincial Pipeline
Interstate Pipeline
Lakehead Pipeline
Magnolia Pipeline
Minnesota Pipeline
Ohio Oil Company
Okla.-Miss. River Pipeline
Pasotex Pipeline
Pembina Pipeline
Phillips Pipeline
Plantation Pipeline
Rocky Mountain Pipeline
Salt Lake Pipeline
Shamrock Oil Company
Service Pipeline
Shell Pipeline
Sinclair Pipeline
Sohio Pipeline
Southern Pacific Pipeline
Standard Oil of Ind. Pipeline
Sun Pipeline
Texas Company
Tidewater Assoc. Pipeline
Trans-Mountain Pipeline
Trans-Northern Pipeline
Tuscarora Pipe Line
Union Oil Pipeline
Westpur Pipeline Company

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
General Offices: 2800 N.W. Front Avenue, Portland 10, Oregon
Factories: Portland, Ore. • Vancouver, B. C., Canada

SALES AND SERVICE OFFICES

BOSTON, MASS.
CHICAGO, ILL.
CLEVELAND, OHIO
DALLAS, TEXAS
DENVER, COLO.
HOUSTON, TEXAS
KANSAS CITY, MO.
LOS ANGELES, CALIF.
NEW ORLEANS, LA.
NEW YORK CITY, N.Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

Fast help on corrosion control – A big Texas natural gas plant required periodic analyses to determine whether MEA solution was breaking down in regeneration, forming corrosive salts. Samples were being sent out of state for analysis, "took forever" to get results. Enter Allied. Now tests are run in Dallas, results come back *fast*, help this plant prevent corrosion before it can start.

New plant start-up trouble quickly traced – Slug of distillate filled inlet scrubber, carried over to amine system. Aqueous amine solution thoroughly contaminated with hydrocarbon. Customer shut down plant, was going to dump entire charge. Allied specialists diagnosed trouble as too rich amine concentration, then suggested decanting solution into empty tanks, which saved half of charge.

Foaming in glycol plant – Customer wanted to know what caused it, how to stop it. Allied specialists flew to the site, deduced cause of the trouble in a matter of hours. Lab analysis confirmed their findings. In a recommendation just five typewritten lines long, they told customer how to solve the problem completely, economically.

USE GLYCOLS OR AMINES?

ALLIED technical service is ready–right now–to help you find straight answers to knotty problems

BASIC TO AMERICA'S PROGRESS

Allied Chemical

NITROGEN DIVISION
Dept. GA5-55-2, 40 Rector Street, New York 6, N. Y.

2819

Sherman's 1959 Panther Power Digger

with All New Loader Attachment

The Improved Panther blends feature knowledge from over 17,000 installations with the imagination and skill of Sherman's research and engineering.

Go Ahead! Compare! Sherman is the Standard of Comparison!

- ★ Exclusive Sherman Hydra-Loop provides hydraulic power at both ends of tractor simultaneously.
- ★ Lightning Detach frees tractor for other jobs in two minutes without special tools.
- ★ Dirty Filter Indicator guarantees maximum all-around performance.
- ★ Easy oil filter accessibility saves time, eliminates work, simplifies maintenance.
- ★ 2800 Sherman dealers throughout U. S. and Canada assure you of prompt parts and service for dependable and economical operation.

AND **. . . for the first time, the all new Sherman Loader is available as companion equipment. With 2000 lbs. lift, 4000 lbs. breakaway capacities. (2500 lbs./5000 lbs. for Ford Industrial or Fordson Power Major tractors.) The improved Panther and new Loader give you an excavating-materials handling unit that outperforms, outmaneuvers any comparable equipment on the market today!**

SHERMAN S PRODUCTS

POWER DIGGERS • LOADERS • SOIL WORKING TOOLS

SHERMAN PRODUCTS, INC.

Royal Oak, Michigan

See Your Ford Tractor Dealer Today

SHERMAN PRODUCTS, INC.
3200 W. 14 Mile Rd., Royal Oak, Mich.

Please send me Bulletin No. 1594 on the Sherman Panther Power Digger and All New Loader.

Name_____

Address_____

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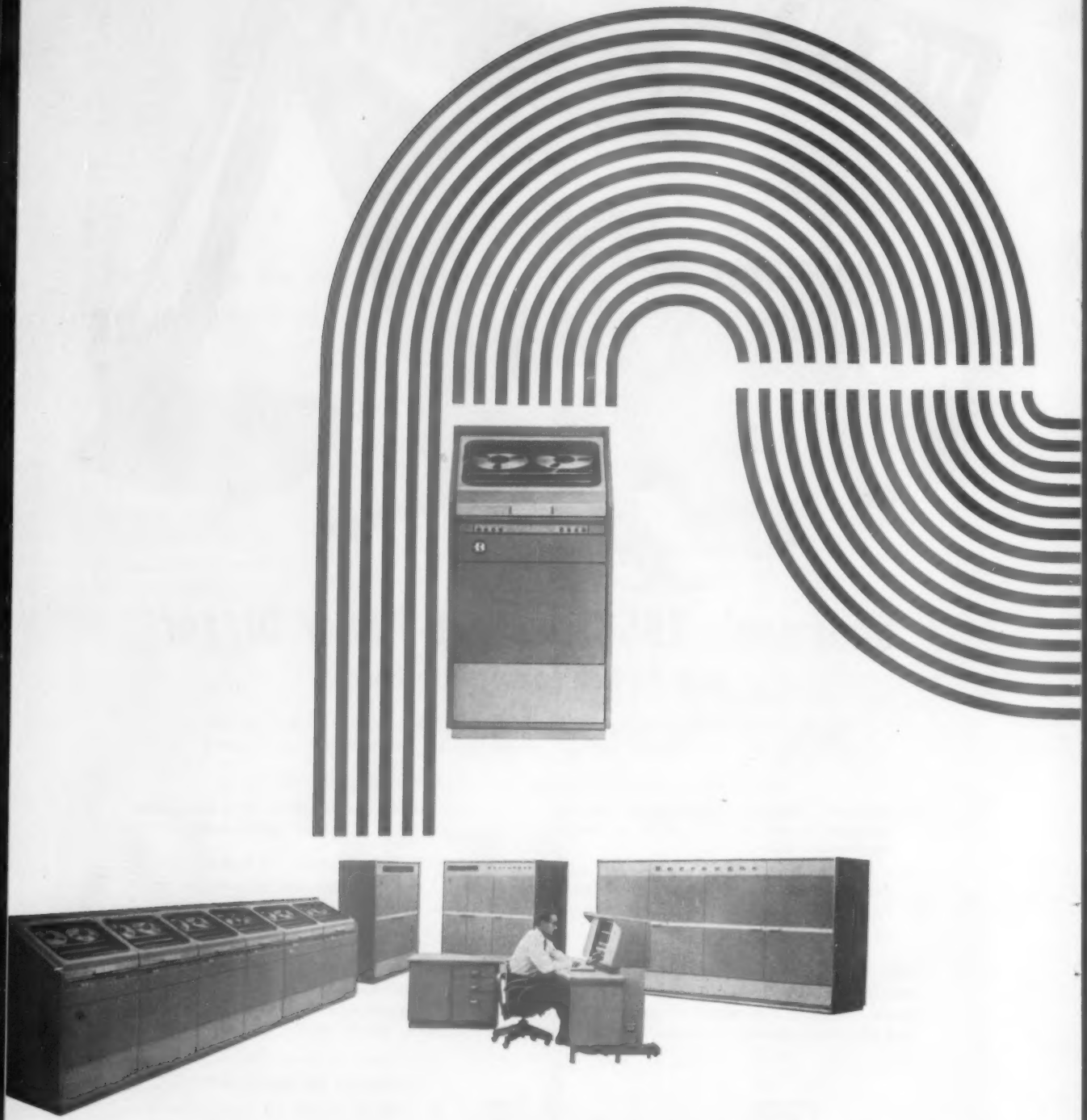
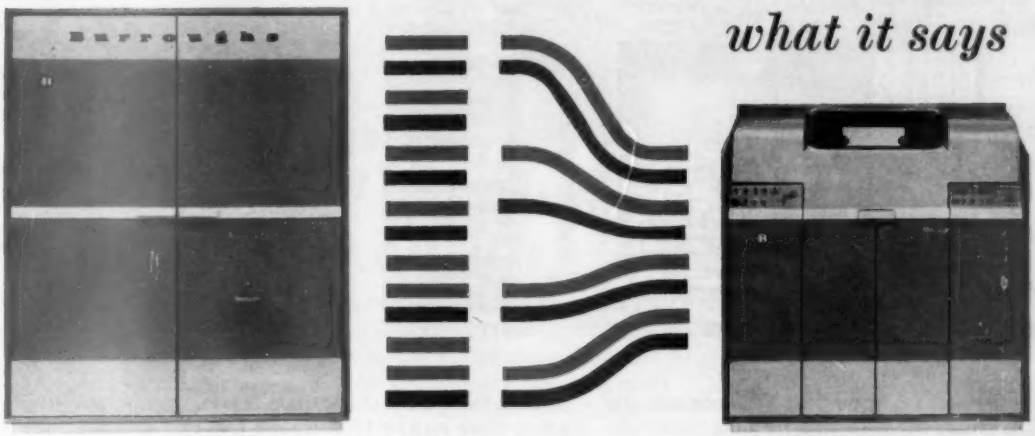


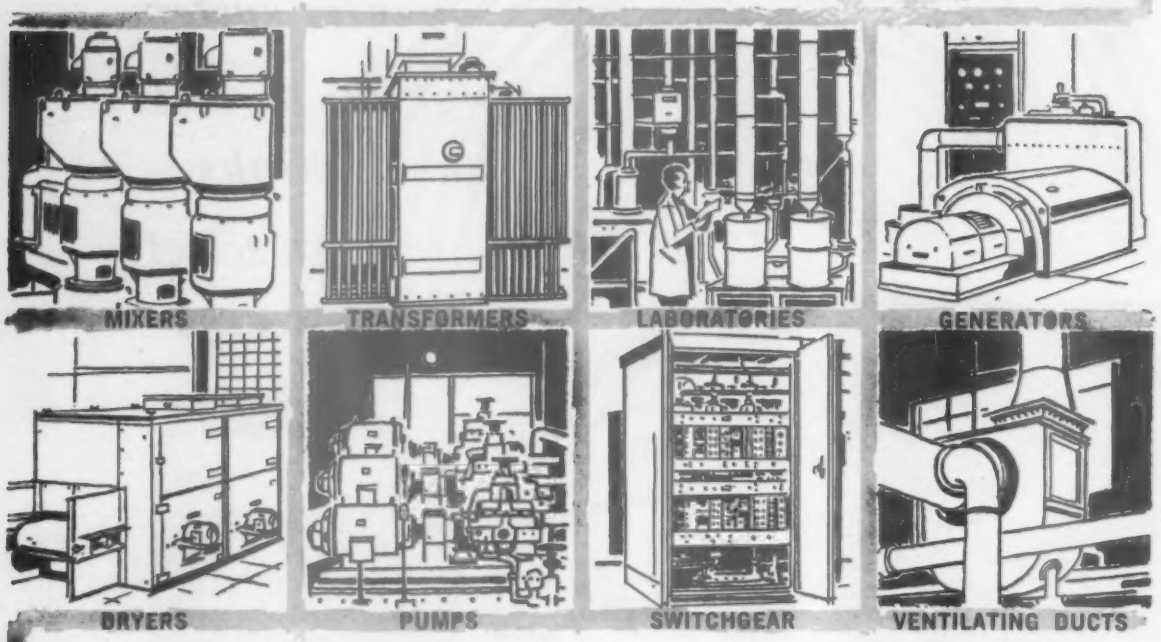
the new
Burroughs 220
high speed
printer system
prints as fast
as it thinks
and can select
what it says



Cut your volume printing jobs down to size with the new Burroughs 220 High Speed Printer System. Printing up to 1500 lines per minute, this transistorized system operates on-line directly from the 220 Computer, or can be fed off-line from one or two 220 magnetic tape files, freeing the computer for other tasks. Built-in magnetic core memory automatically stores, edits and prints out data in whatever format you need. It selects, deletes or merges information to produce neat, legible documents . . . *reports, insurance premium notices, data reduction tabulations, utility bills, labels, bank statements,* or whatever you require. All computer editing steps are eliminated, saving you valuable computer hours in obtaining printed information. This new printer system makes the Burroughs 220, already the most advanced computer in the medium price class, an even faster, more versatile data processing system for business and scientific applications. It is only a part of Burroughs' complete line of advanced data processing systems...all in production...now at work in hundreds of installations...and supported by a nationwide team of computer specialists. Write for Bulletin No. 5221, ElectroData Division, Pasadena, California.

Burroughs Corporation *"NEW DIMENSIONS/in electronics and data processing systems"*

Which of these common fire hazards threaten you?

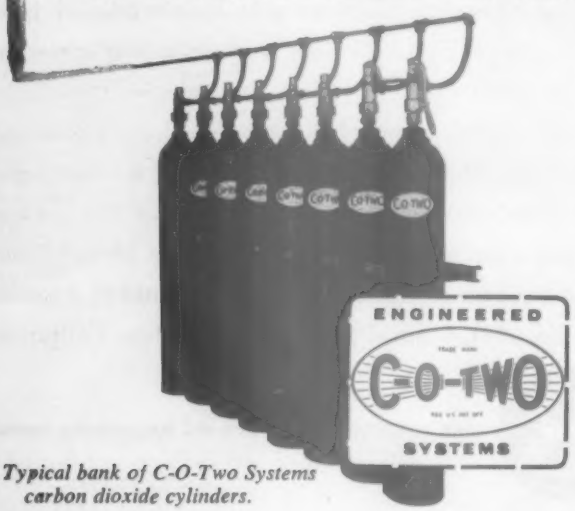


If your plant has one or more of these common fire hazards, ordinary fire protection may not prove adequate! You also need special fixed-type protection that constantly guards specific highly hazardous areas!

C-O-Two Fire Extinguishing Systems are specially designed for closed or partially-closed spaces in which highly flammable liquids or solids are manufactured, handled or stored . . . or where there is fixed or rotating electrical equipment. The C-O-Two line includes dependable, high-quality carbon dioxide, dry chemical or foam systems to extinguish fire, plus detecting systems to detect and locate fire automatically.

Your experienced C-O-Two representative is well qualified to carefully analyze all special hazards. Because he offers the industry's largest line of fire protection products and services, he can make equipment recommendations without prejudice. Each C-O-Two System is carefully engineered and manufactured . . . and C-O-Two will also expertly install the system, if desired.

Why not review your common fire hazards now? If protection is either lacking or inadequate, you can confer at no obligation with your nearby C-O-Two Industrial Fire Protection Engineer! Call him today at these offices:



Typical bank of C-O-Two Systems carbon dioxide cylinders.

products of
THE FYR-FYTER COMPANY

ATLANTIC COAST REGIONAL OFFICE
P.O. Box 750, Newark 1, New Jersey
CENTRAL STATES REGIONAL OFFICE
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PACIFIC COAST REGIONAL OFFICE
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BRANCHES: Atlanta, Baltimore, Boston, Chicago, Dallas, Dayton, Detroit, Los Angeles, New York, Newark, Philadelphia, Pittsburgh, Portland, Rochester, San Francisco, Seattle, Toronto (Ontario). Representatives and Distributors in all principal cities.

BIDDING POWER!

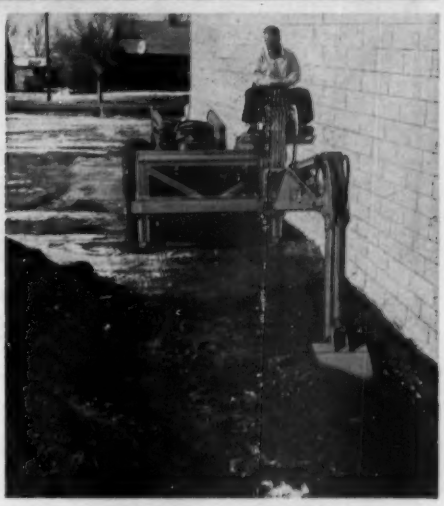
MASSEY-FERGUSON'S
DAVIS BACKHOE
pays off where others balk!

Increase your power to bid on the more profitable backhoe jobs — ones that an ordinary backhoe can't handle. You can do it with the powerful Massey-Ferguson Davis 220.

This rugged unit has 14,000 pounds breakout power. Tears through hard or frozen ground and blacktop. Its high operating pressure (2150 psi), extra large bucket cylinder, 200° continuous operating arc, easy-to-operate controls, and direct-to-the trench vision let you work faster and more accurately than with any other backhoe.

Of course its unique ability to dig flush alongside walls or fences will definitely put you "in" where others can't compete. And, it can work in cramped quarters — at right angles to the tractor.

It uses the same hydraulic system as the famous Massey-Ferguson Davis Loader. Both are designed as integrated attachments to Massey-Ferguson's Work Bull 202 and 204 Industrial Tractors — by far, the most popular tractor-loader-backhoe rig today!



Gets Ready to Dig Flush In Less Than 5 Minutes

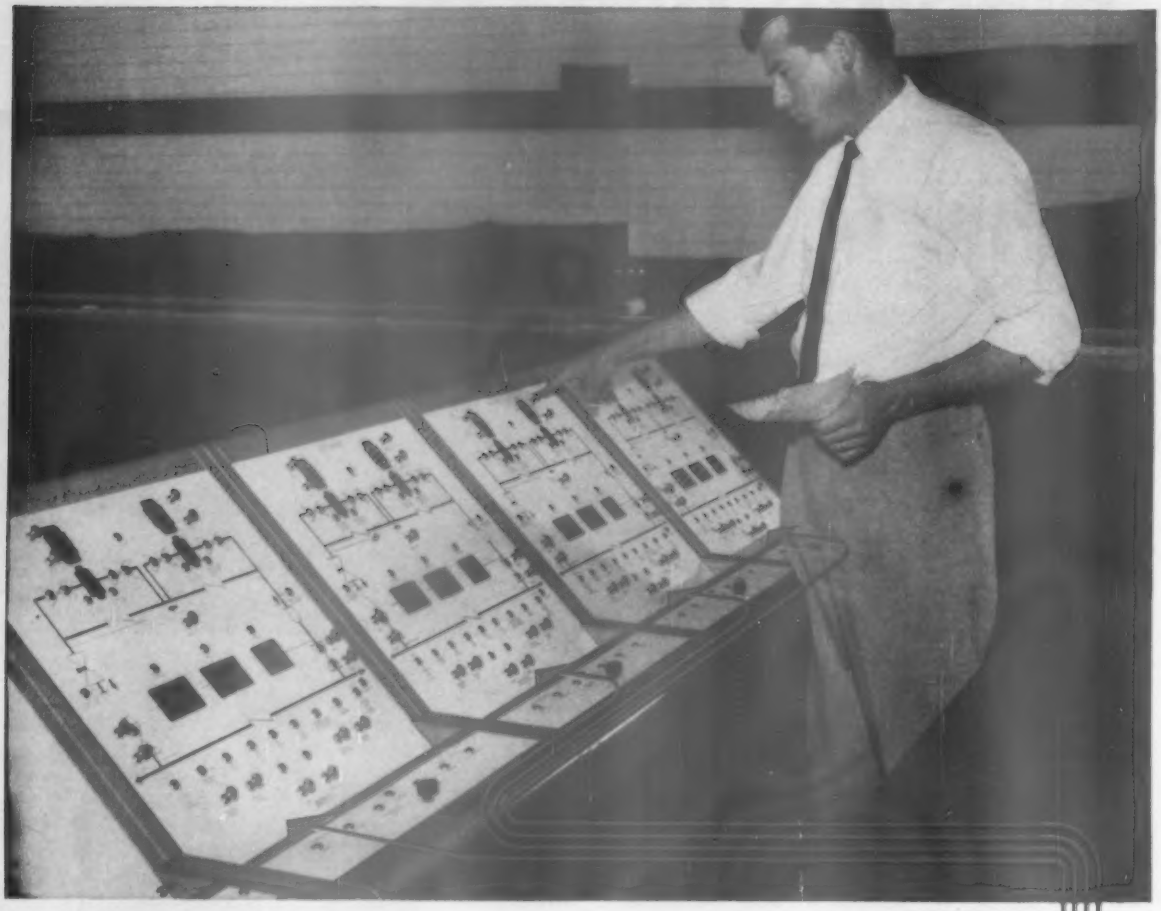
Exclusive Hydra-Slide positioning lets you shift mast, boom, and seat from center to side in a matter of minutes. Notice the operator always stays in line with the trench for unparalleled vision.

Why Wait? Set a Date — We'll Demonstrate!

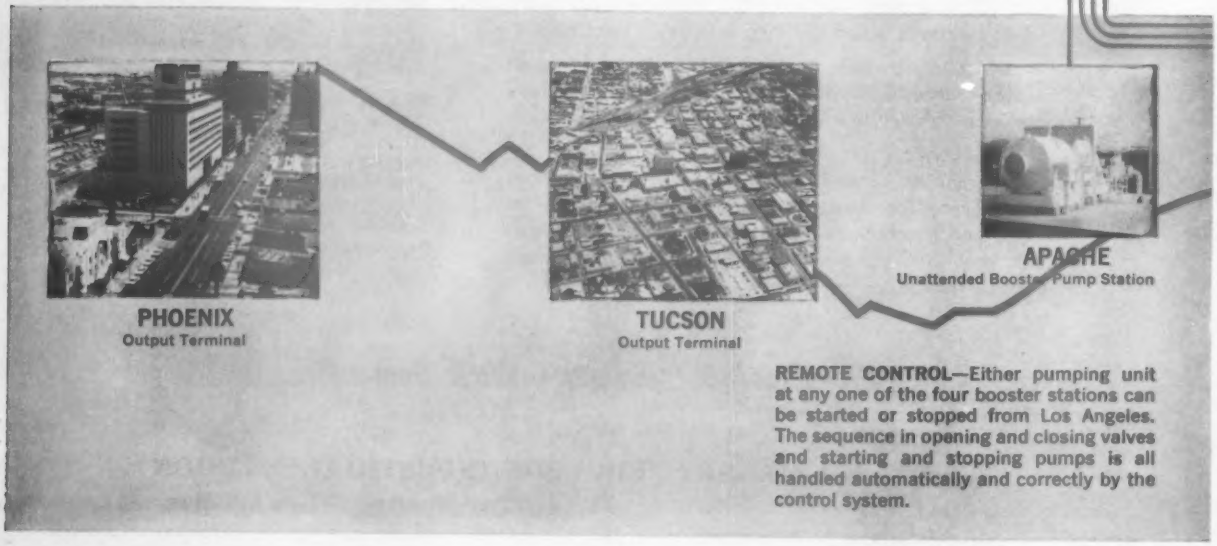
MASSEY-FERGUSON INDUSTRIAL DIVISION

Block 1000 South West Street • Wichita 13N, Kansas

Union Centralized Transport Control pays



LOS ANGELES CONTROLLING OFFICE—The heart of the whole operation is in Los Angeles where one man at the control console can supervise the operation of four unattended pump stations 643 to 804 miles away. The operator has complete information before him showing conditions all along the line.



REMOTE CONTROL—Either pumping unit at any one of the four booster stations can be started or stopped from Los Angeles. The sequence in opening and closing valves and starting and stopping pumps is all handled automatically and correctly by the control system.

off for Southern Pacific Pipe Lines

Push a button in Los Angeles and four pump stations throb into action out on the desert over 600 miles away

Union Switch & Signal equipment controls operating sequence and telemeters operation of 33,000 bbl/day products line

FLEXIBILITY and fail-safe operation are the keynotes of the new pipeline system operated by Southern Pacific Pipe Lines, Inc. The line is used to transport refined products such as gasoline, jet fuel, diesel oil, etc., from El Paso, Texas, to Tucson and Phoenix, Arizona. All Centralized Transport Control equipment for four unattended booster stations was supplied by Union Switch & Signal.

REMOTE or LOCAL: All four booster stations are normally controlled from Los Angeles. Any station can be controlled locally, when desired. In any case, continuous pressure and suction readings are displayed on the console at Los Angeles and automatically recorded every fifteen minutes by an automatic typewriter. Any malfunction, at any point in the system, is indicated on the console. The equipment affected is shut down automatically and cannot be started again until the trouble has been cleared.

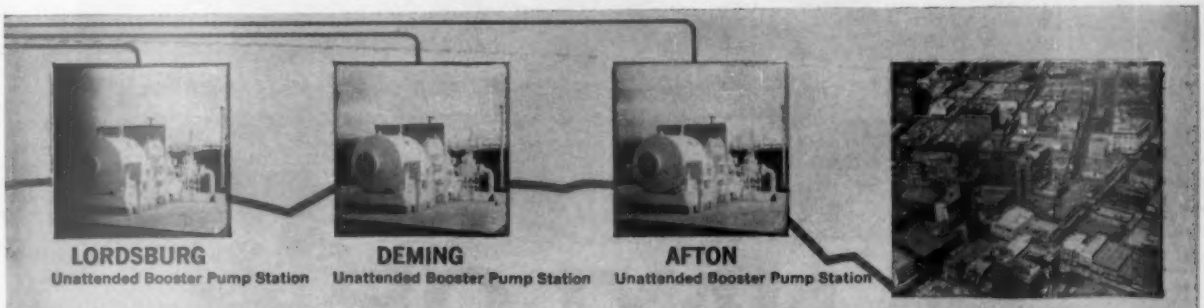
COMMUNICATION: Four telegraphic-type communications lines, owned by Southern Pacific, are used to transmit control codes to the stations and telemetered information back to Los Angeles. Each line serves one station. An additional commercial communications line serves as a stand-by for all four stations. Signals are coded to prevent noise or interference from causing faulty operation or indication.

MAXIMUM EFFICIENCY: The Centralized Control system, designed and installed by Union Switch & Signal Division of Westinghouse Air Brake Company, cuts down the chance for expensive error. It keeps the Southern Pacific Scheduling Department in Los Angeles informed, at all times, of exactly what is happening in the field. It speeds operation, adds security and reliability.

Union Switch & Signal has designed many successful custom systems for pipeline companies. And now out of that experience, it has developed standardized central control systems that cut costs, add flexibility, and save space, as well as making pipeline control extremely reliable.

"Pioneers in Push-Button Science"

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA



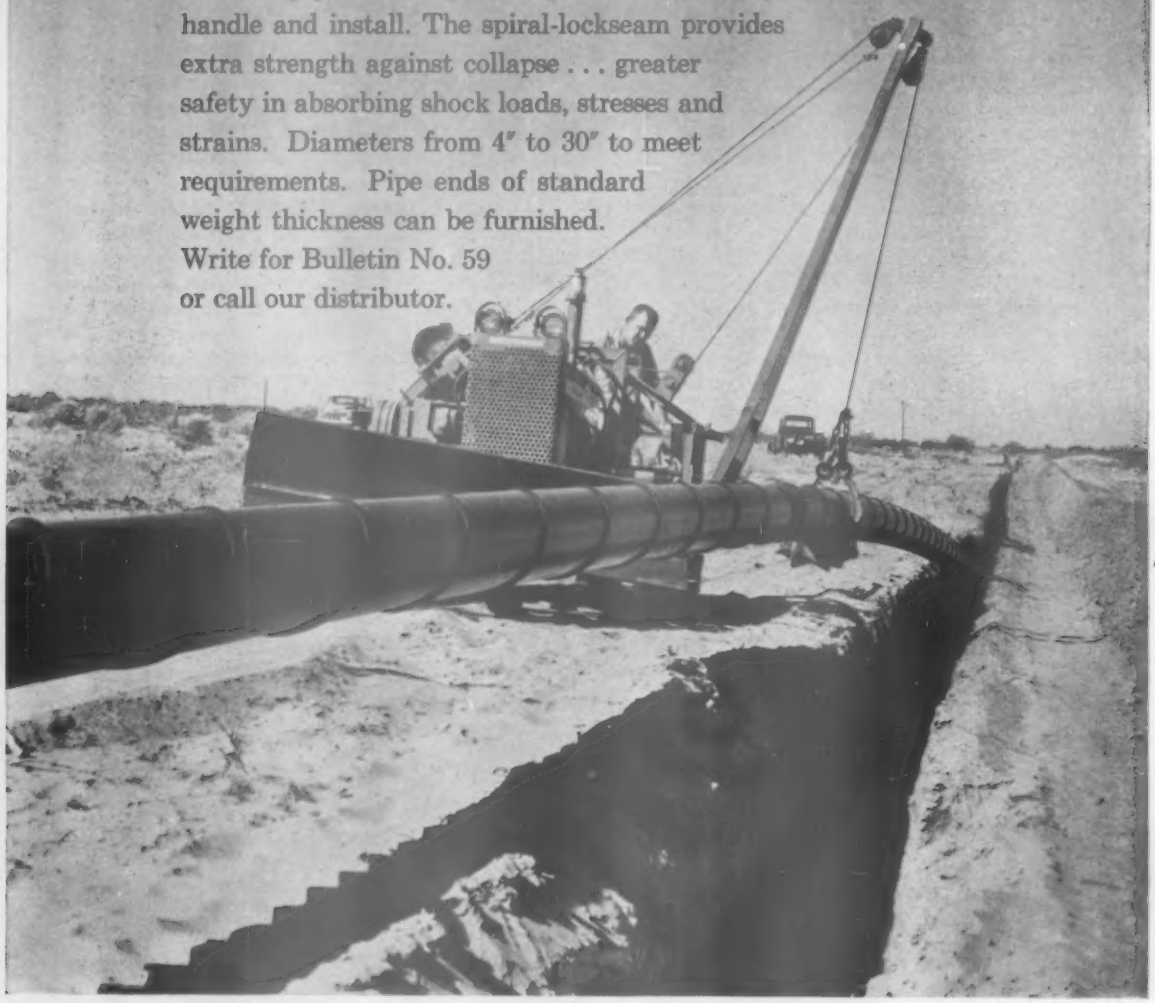
LOCAL CONTROL—Operation also can be controlled automatically at the pump station. Or the station can be run manually. The choice is up to the local station. But Los Angeles always knows which mode of control is being used and always receives a continuous flow of system information.

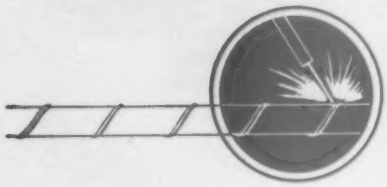
THE FUTURE—Southern Pacific Pipe Lines, Inc. can already see opportunity to make this system more automatic and more efficient. They plan, in time, to be able to let stations adjust automatically to proper unit operation when an upstream or downstream station goes off the line.

Depend on NAYLOR

For Dependable Pipe Lines

NAYLOR Spiralweld pipe gives you what you need for pipe lines in gathering service. It's easy to handle and install. The spiral-lockseam provides extra strength against collapse . . . greater safety in absorbing shock loads, stresses and strains. Diameters from 4" to 30" to meet requirements. Pipe ends of standard weight thickness can be furnished. Write for Bulletin No. 59 or call our distributor.





NAYLOR PIPE Company

1232 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 60 East 42nd Street, New York 17, N. Y.

EXCLUSIVE DISTRIBUTORS IN MID-CONTINENT AND GULF COAST AREAS: MID-CONTINENT SUPPLY CO. • Fort Worth, Texas and Branches

cost-cutting gas boosters

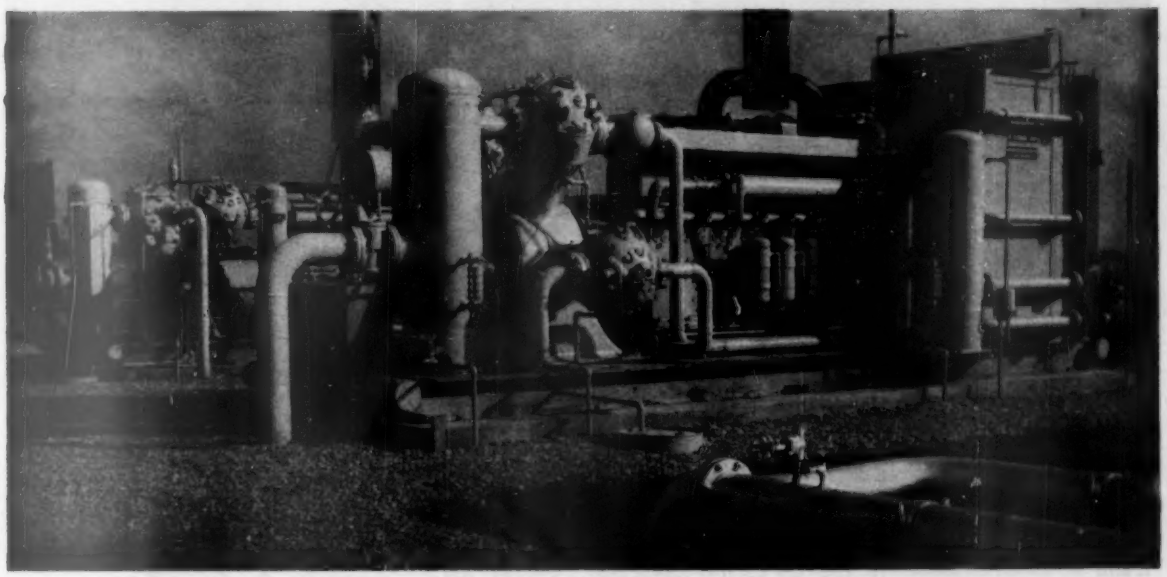
In a recent 12-month period, Sunray Mid-Continent Oil Company installed 11 "packaged" gas compressors, each dependably powered by a White Superior gas engine. Every day 4050 HP from the Superiors drives compressors that deliver 37,475,000 cubic feet of gas for Sunray's expanding gathering program!

Throughout gas and oil fields, rugged, compact Superior engines are proving economical, both in purchase price and operating costs. For example, because of the ability of Superior engines to deliver required HP at low speeds, the engines are directly coupled in engine-compressor packages. This eliminates the need for expensive gear reducers, results in smooth continuous performance and low fuel consumption.

Superiors' extreme design simplicity, precision construction and many advanced engineering refinements reduce maintenance and repair and greatly prolong engine life.

Superior engines are available in diesel, dual-fuel and gas engines from 190 to 2150 HP and in portable or stationary generator sets from 150 to 1500 KW. Get complete information from leading oil field distributors, White oil field representatives, or through White Diesel Engine Division.

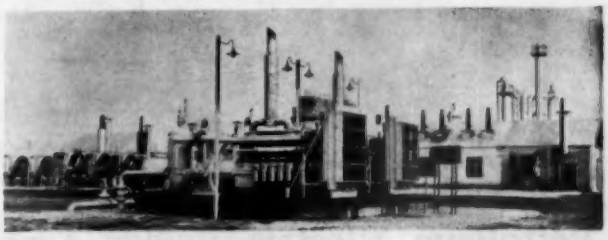
Sunray Mid-Continent expansion program includes 11 new Superior-powered compressors



Superior ENGINES ATLAS Imperial DIESEL ENGINES White DIESEL

White Diesel

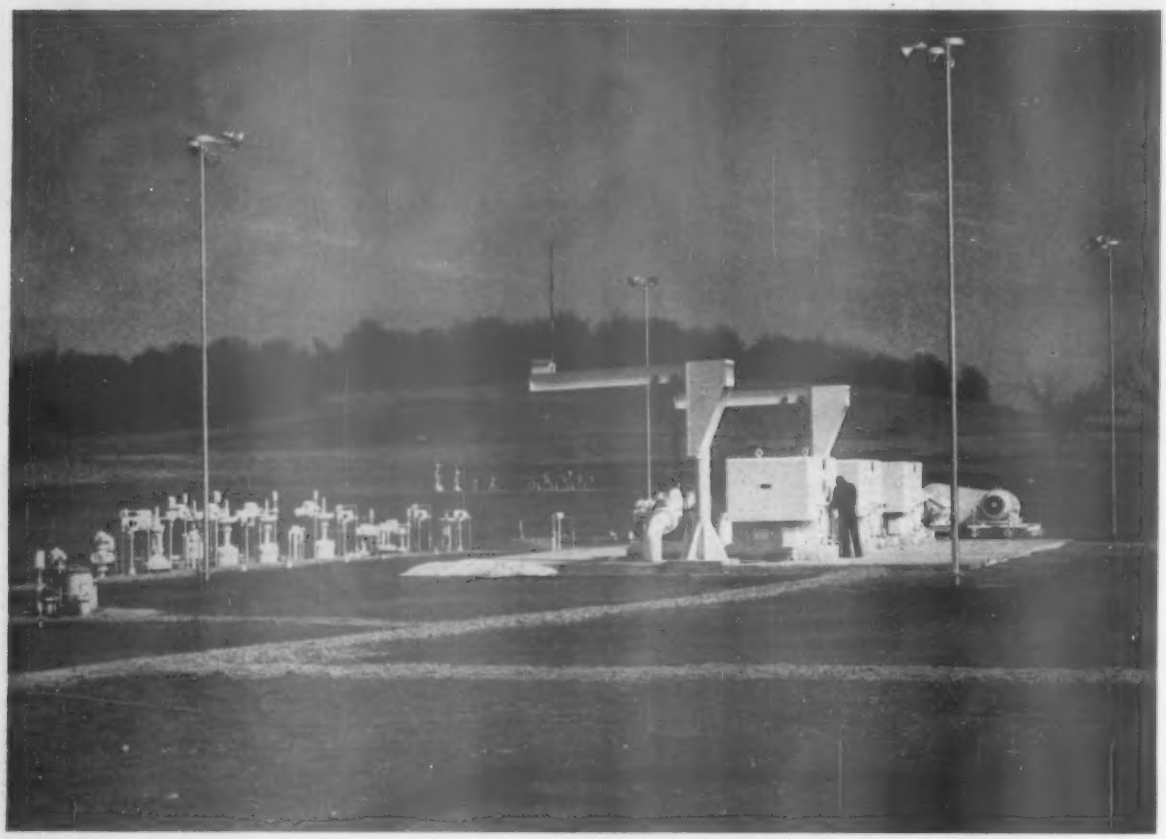
WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY
Plant and General Offices: Springfield, Ohio



Superior 8G-825 eight-cylinder gas engines driving gas boosters at Sunray's West Moore Field, Cleveland County, Oklahoma.

You can depend on purchased electric power for

REMOTE CONTROL



Remote-controlled crude station with three 1250 hp and one 200 hp electric motors

This remote-controlled crude station is typical of the modern trend in electrification. In addition to the four electric motors, the valves and sump pump are all controlled from a town some distance away. This installation is dependably served with utility electric power and a fine example of adaptability of purchased power to remote control.

For pipelines, as well as for producing fields and refineries, you can always depend on utility electric power. See your nearest utility electric power company for assistance or write the Petroleum Electric Power Association.

Purchased Electric Power . . . saves money, manpower, maintenance, and serves you better automatically

Petroleum Electric Power Association P. O. BOX 35006. DALLAS 35, TEXAS

AE-Lenkurt

HAS **EVERYTHING** YOU NEED FOR SYSTEM-WIDE COMMUNICATIONS

Microtel Microwave equipment, for instance—

Lenkurt *Microtel* provides maximum channel capacity per dollar, plus high-quality transmission . . . allows more protection against fading.

For instance, with Lenkurt 45BX Carrier, a single 6000-mc *Microtel* unit can accommodate from 4 to 264 voice channels. Channels may be dropped or inserted at any point.

Lenkurt *Microtel* has the additional advantage of being economical in operation. Power consumption is less than 300 watts. An advanced type of automatic frequency control dispenses with the need of crystal ovens or blowers. With the use of r-f circulators, 2, 3 or 4 *Microtel* terminals may be operated on a single antenna system.

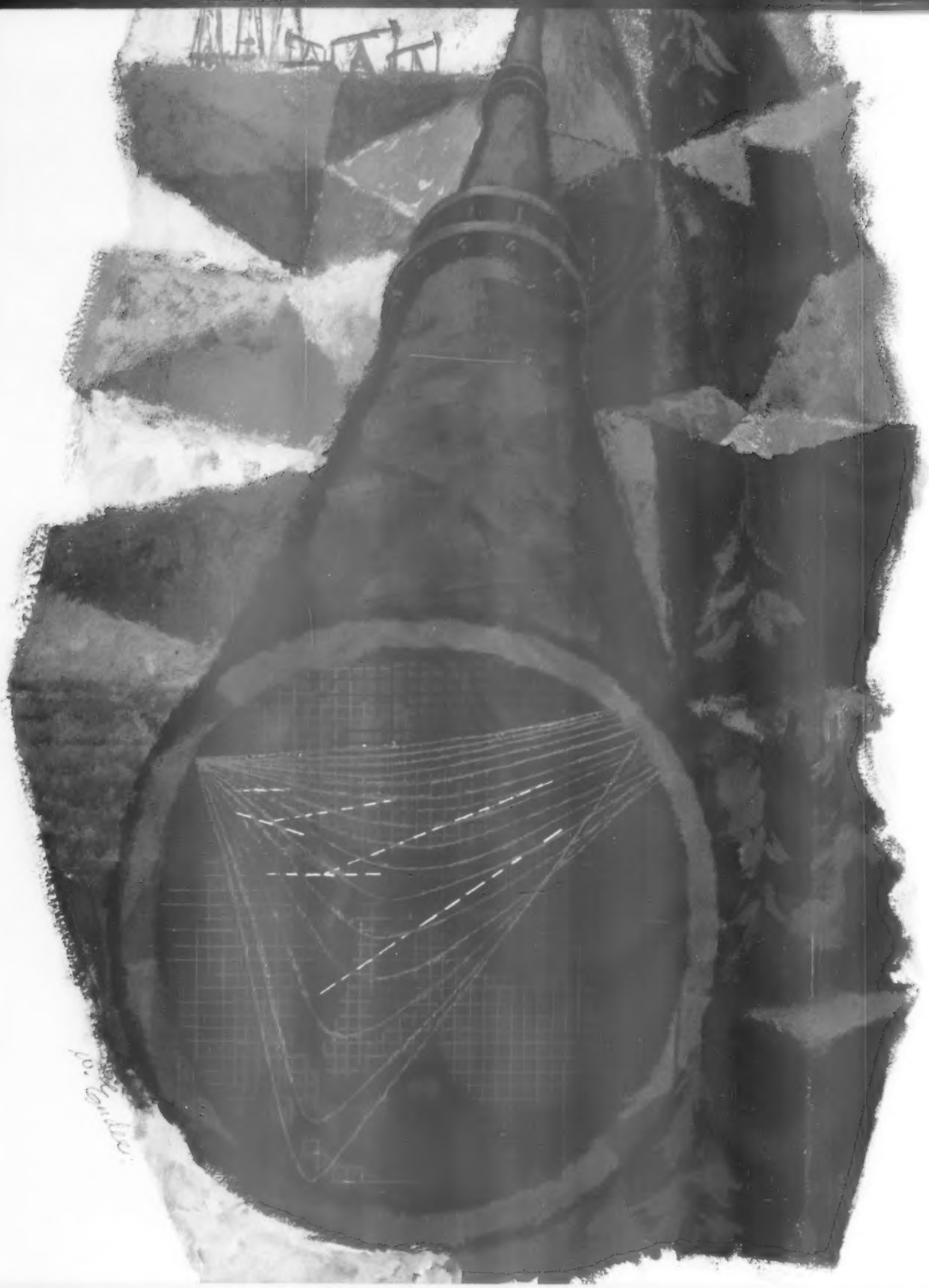
Whether your expansion program calls for carrier, microwave, data transmission or supervisory control, AE-Lenkurt has the equipment, *plus* the engineering teams and talent, to handle the project from start to finish. And AE-Lenkurt services are tailor-made to your requirements.

For more details on packaged planning and services, call your Automatic Electric representative, or write the Director, Petroleum Sales, Automatic Electric Sales Corporation, Northlake, Illinois.

AUTOMATIC ELECTRIC GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS



CLARK

CLARK BROS. CO.
compressors and
gas turbines

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advanced scientific research

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steel structures
and buildings

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electronic transformer
development-manufacture

IDECO Inc.

IDECO, INC.
complete drilling rigs

DRESSER INDUSTRIES, INC.

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PACIFIC

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CLARK

DRESSER MANUFACTURING DIVISION

IDECO Inc.

A graph of gas compressibility factors veiling the face of an imaginative man, at left, thematically shows the complexities of the tremendous task of moving the nation's daily production of natural gas to virtually every community. The Dresser companies are leaders in the manufacturing of vital equipment for all phases of this vast gas industry. Throughout the free world's oil, gas, chemical and electronic industries, Dresser products and technical services have long been known as the standard of comparison.

LANE WELLS
LANE-WELLS COMPANY
technical oilfield services

Magcobar
MAGNET COVE BARIUM CORP.
drilling mud and chemicals

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PACIFIC PUMPS, INC.
pumps of various types

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blowers, meters, vacuum pumps

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rock bits and oilwell drilling tools

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NOW! *Direct connecting service from Texas and Oklahoma via Western Airlines to*

EDMONTON • CALGARY
and Casper, Wyoming

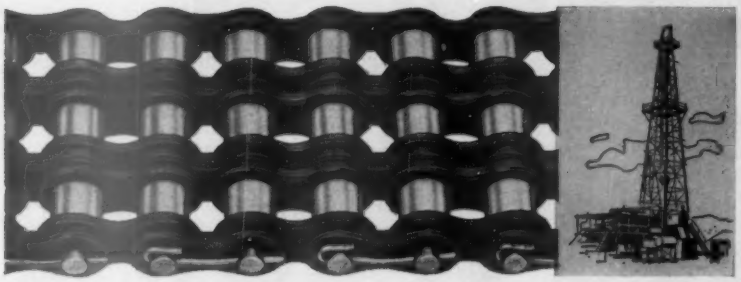
Braniff serves
both U.S.A. and
South American oil fields
...as no other airline does!

BRANIFF *International* **AIRWAYS**

General Offices: Dallas, Texas

NEW Gardner-Denver Drawworks

. . . ready to run with LINK-BELT FR® Roller Chain



LINK-BELT IS PROUD TO ANNOUNCE that Gardner-Denver is using Link-Belt Fatigue Resistant Roller Chain on their new 2100 drawworks! Fortified against fatigue, FR roller chain helps this rig achieve smoother going the entire trip—faster penetration, more on-bottom time, unmatched durability for hoisting service.

Link-Belt's FR process increases strength where it's needed most—the critical sidebar areas most vulnerable to fatigue failure. By compressing the metal around pitch holes, FR greatly raises the chain's endurance limit . . . assures non-stop drilling through the toughest formations.

Welcome, Gardner-Denver! We're honored to be your power transmission partner.

LINK-BELT

FL130

ROLLER CHAINS AND SPROCKETS

LINK-BELT COMPANY: Indianapolis 6, Houston 1, Dallas 26, Odessa, Tex., New Orleans 16, Shreveport, La., Los Angeles 22 (Montebello), Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields.

SAVE 4 MEN . . . 1 TRACTOR . . . WITH GARDNER-DENVER

Centralized remote controls

Hydraulic positioning

12' drill feeds

4" and 4½" bore drills

High-torque feed motors

Drills four holes at a time

Team up your "Quadril" with the Gardner-Denver RP900 rotary portable compressor. It's built to deliver 900 cfm in all climates, altitudes and weather. Water-oil cooled. Clutch prevents cold-weather "dry starts" . . . permits compressor oil to be warmed before engaging compressor. "THRIFTMETER"® fuel control saves gas . . . wear and tear on engine and compressor. Easy-to-get-at parts simplify field inspection and maintenance. Write for Bulletin RC-1.

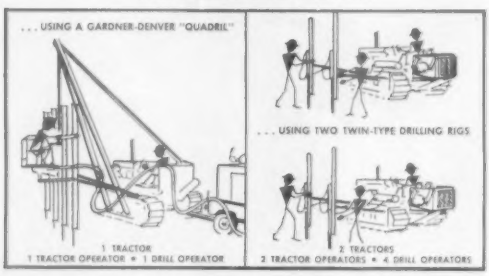
Keep your spread on the move over rough, rocky ground with the Gardner-Denver "Quadril"*. The "Quadril" will ride a side boom anywhere . . . drill four fast holes at a time with one man at the controls.

The unit has completely hydraulic positioning, plus centralized remote controls for each drill and feed . . . for blowing and hole cleaning. Center to center distance between drills adjustable to 40". Holes of 12' depths can be drilled without a steel change . . . locked-in chuck and ring seal shank prevent dropped steels and assure better hole cleaning.

And the "Quadril" saves time, equipment and manpower . . . eliminates tractor, tractor operator and two drillers needed for twin-type drilling methods. Write for bulletin.

*Trade-mark

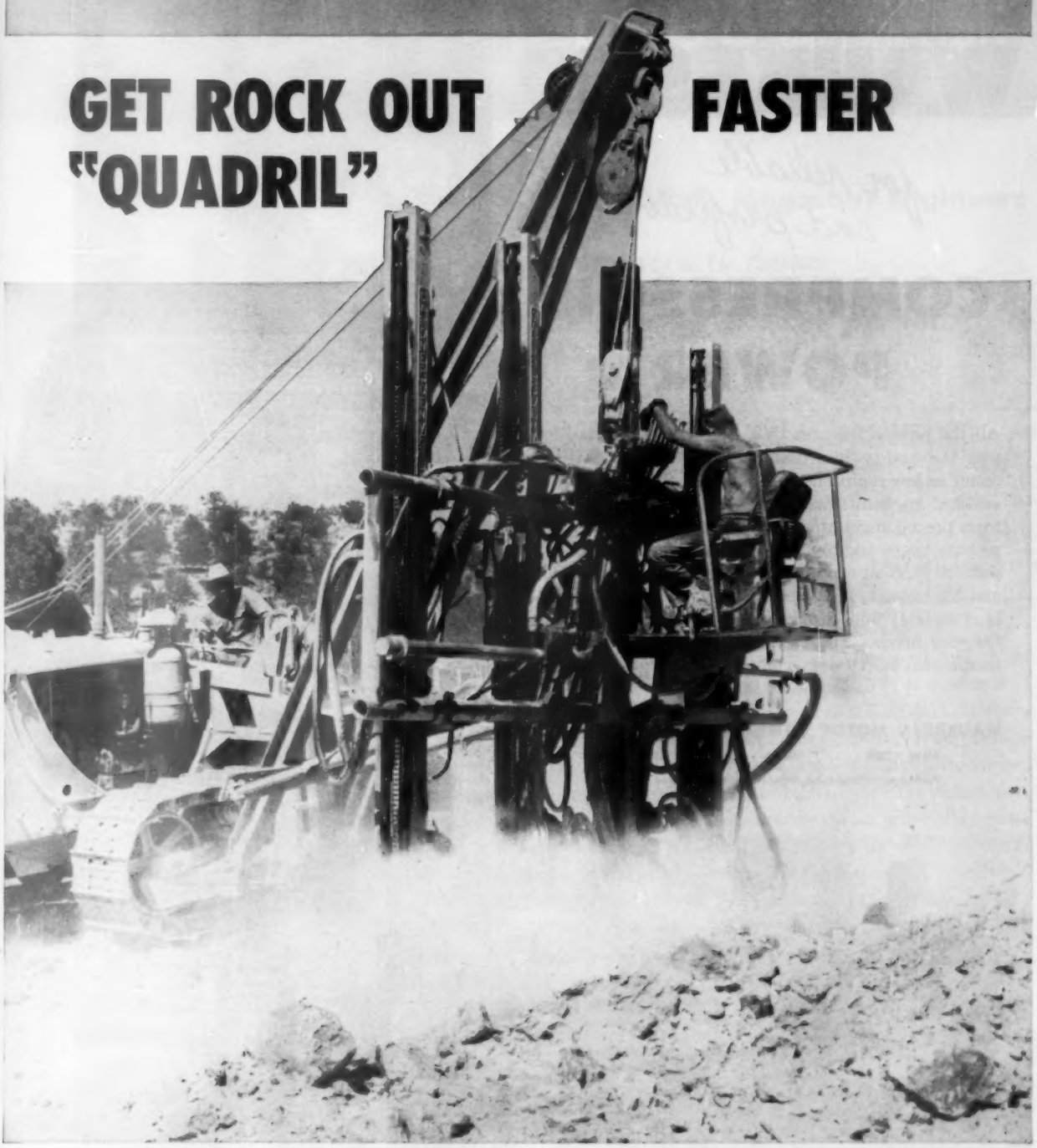
What it takes to drill four blast holes


. . . USING A GARDNER-DENVER "QUADRIL"
1 TRACTOR
1 TRACTOR OPERATOR • 1 DRILL OPERATOR
. . . USING TWO TWIN-TYPE DRILLING RIGS
2 TRACTORS
2 TRACTOR OPERATORS • 4 DRILL OPERATORS

A MAN ON THE GO

Gardner-Denver equipment specialists know there's no substitute for keeping up to date on equipment performance firsthand—in the field. At Gardner-Denver there's no substitute for men—our 100-year philosophy of growth.

GET ROCK OUT FASTER "QUADRIL"



EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario
Gardner-Denver Export Division, 233 Broadway, New York 7, N. Y.
Oil Field Offices: Casper, Cleveland, Columbus, Corpus Christi, Dallas, Denver, Durango, Edmonton, Ellinwood, Evansville, Houston, Huntington, Jackson, Kansas City, Lafayette, Los Angeles, Mexico City, New Orleans, Odessa, Oklahoma City, Pittsburgh, San Francisco, Shreveport, St. Louis, Tulsa, Wichita, Winnipeg

GARDNER-DENVER uses WAUKESHA

for reliable and profitable

COMPRESSOR POWER

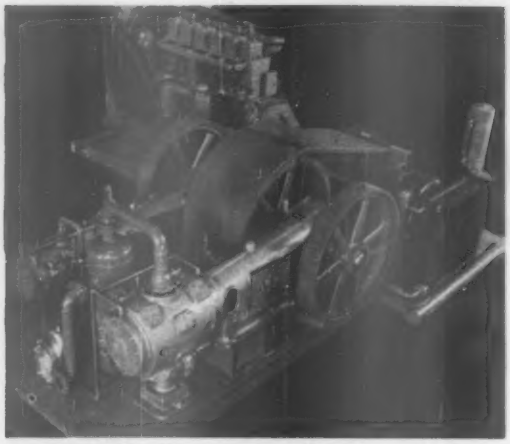
All the proven features that insure long engine life and the ability to withstand overloads, and that result in low maintenance costs and economical operation, are built into these Waukesha engines . . . from precision-counterbalanced rugged crankshafts; pistons, rings, and rod and pin assemblies in matched sets, to built-in automatically lubricated governors and big capacity cooling and oiling systems. The line is complete; you can get exactly the right power for your needs. You cannot buy better engines for continuous heavy duty compressor operation.

Send for engine bulletin 1699.

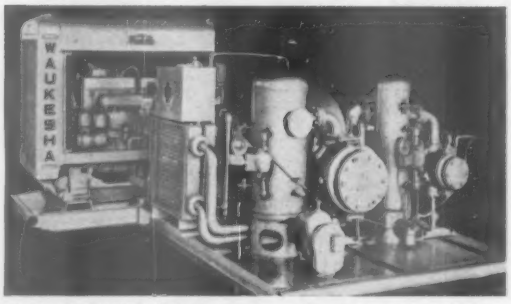
WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

NEW YORK TULSA LOS ANGELES

Factories—Waukesha, Wisconsin, and Clinton, Iowa



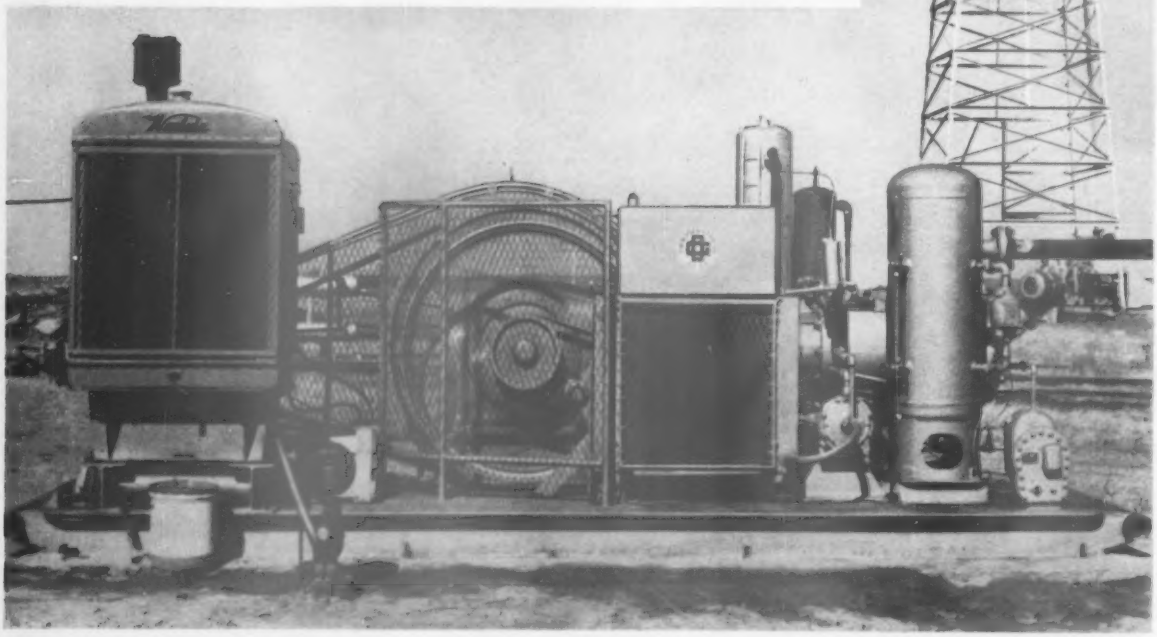
Waukesha LRORB 2894 cu. in. gas engine, 6-cyl., 8½ x 8½-in., powers 2-stage RX **Gardner-Denver** gas booster package unit.



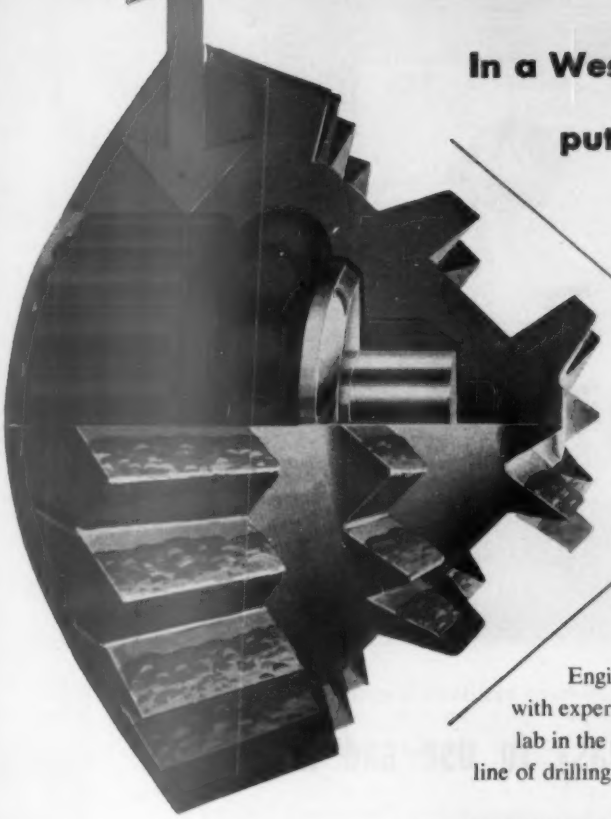
Waukesha WAKB 1197 cu. in. gas engine, 6-cyl., 6¼ x 6½-in., powers 2-stage RX **Gardner-Denver** gas booster package unit.

Near Graham Fox Field, Oklahoma, **Waukesha** 145-GZB 817 cu. in. gas engine, 6-cyl., 5⅜x6-in., powers single stage RX **Gardner-Denver** gas booster package unit.

440



HOW BIT LUBE AND MAGCOBAR ENGINEERING CUT DRILLING COSTS



In a West Texas Well, Magcobar Engineers put a film here *to make* *net savings of $4.87 per foot*

	NO. BITS	BIT SIZE	INTERVAL	ROTATING HOURS	WEIGHT ON BIT	RPM
BIT LUBE-WATER	28	7⅞"	4919-7272	185	70-90,000	80-90
WATER	40	7⅞"	4936-7270	310	45-60,000	55-60

You are always sure of getting every cost-cutting advantage with Magcobar. Here's why: The Magcobar Mud Engineer combines a thorough knowledge of drilling fluid chemistry with experience in your drilling area. This background—plus the top mud lab in the country—gives new dimension to the finest and most complete line of drilling mud products. What does this mean to you? The highest level of product performance to cut your drilling costs.

Here's proof of actual savings using Bit Lube (E. P. Additive for Mud). The table shows a drilling cost comparison in the Brownfield, Texas, area. The Bit Lube well was drilled for $4.87 per foot less than the offset well. Total savings in bits, trips, and drilling was $13,420. Bit Lube and emulsifiers cost $1,940; a net saving of $11,480!

Bit Lube forms a tough protective film to reduce friction and to increase bit bearing life under extreme pressure conditions. It works best with high weight on the bit and fast rotary speed. Bit Lube and Magcobar engineering may be the answer to your bearing failures.

Bit Lube is only one of Magcobar's many answers to the problem of high drilling cost, a problem that demands the right answers. You'll find that the right products *used right* by Magcobar can cut costs on your next well, too.

MAGNET COVE BARIUM CORPORATION
HOUSTON, TEXAS

Magcobar®
Complete
DRILLING MUD SERVICE

Another Well Done with Magcobar Technology!

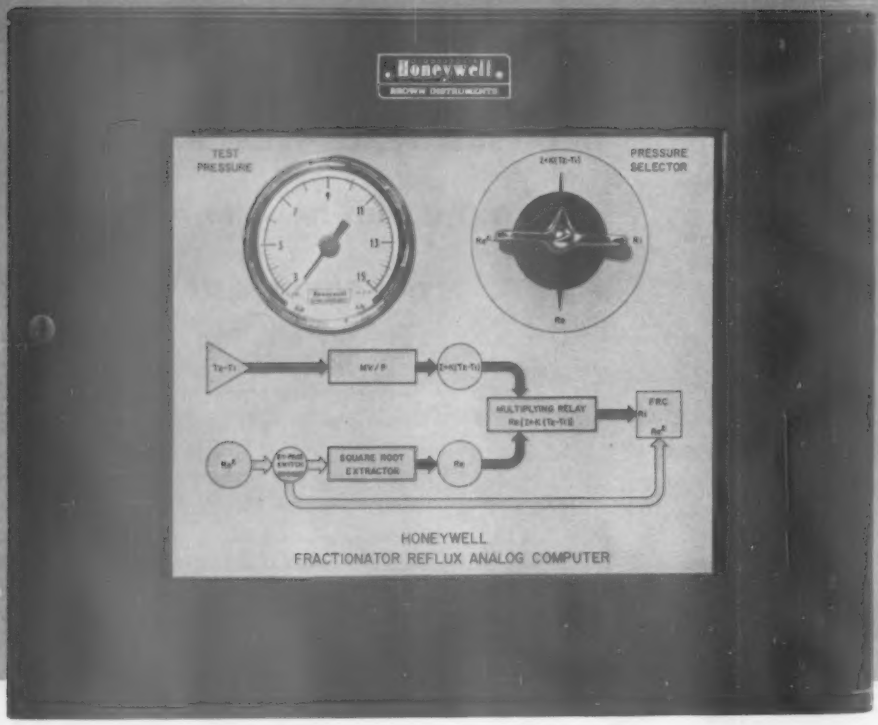
$Ri = Re\ (1 + K\ (T_2 - T_1))$

Ri—Internal reflux

Re—External reflux

$K = \frac{\text{Specific heat of Re}}{\text{Heat of Vaporization of Liquid on top tray}}$

$T_2 - T_1$—Temperature difference between external reflux steam and overhead vapor



Honeywell "Frac" unit is easy to use and maintain

- **Standard Honeywell components**
- **Standard Honeywell strip chart case**
- **Simple, easily accessible connections**
- **Chassis pulls out for front-of-case servicing**

COMPONENTS

MV/P Transmitter (millivolt-to-pressure)

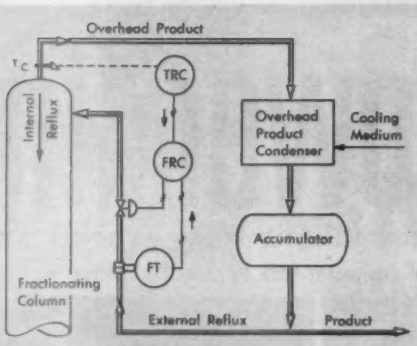
- Fully transistorized
- Continuously sensitive to temperature change
- Constant voltage supply
- Simple span and zero adjustments

Pressure selector and test pressure gage

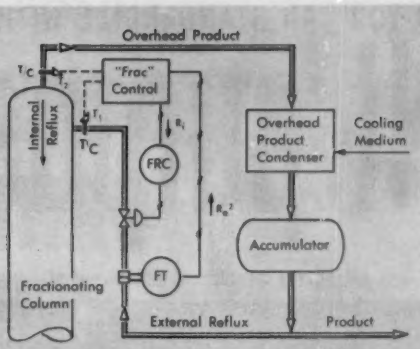
- Provide check of all pneumatic pressures within the computer for simplified trouble shooting.

By-pass switch

- Permits switching from internal to external reflux flow measurement and control.



PROBLEM *with existing system of controlling Fractionator*—Column is upset when (1) temperature of overhead product is indirectly affected by varying atmospheric conditions, and (2) temperature of cooling medium to overhead product condenser varies.



SOLUTION—*"FRAC"* Controller System*—The "FRAC" Controller measures differences in temperature of overhead product and external reflux flow of Fractionator Column. It computes, records and maintains best "Internal Reflux Flow Rates" by adjusting external reflux flow rate to get most efficient Fractionator Column operation.

New Honeywell "FRAC"* Controller stabilizes fractionating column operation

- **Easily Installed and Maintained by Present Instrument Technicians**
- **Savings Realized Justifies Installation**
- **Tamper-proof Design**

This new Honeywell control system immediately adjusts column operation to the effects of ambient temperature on overhead product condenser and external reflux. It continuously computes *internal* reflux flow, to maintain the most efficient, economical fractionating tower operation.

The new method, originally developed and licensed by Phillips Petroleum Company, utilizes a simple Honeywell analog computer employing standard industrial electric and pneumatic instrument components.

In correcting instantly for temperature deviation, the new control system offers many economies. Less reboiler heat is required, because large surges of internal reflux that would lower temperature are eliminated. Reduction in off-specification product minimizes re-runs and the need for intermediate storage. Quicker on-stream time allows fuller use of equipment. Closer control permits fractionator to operate closer to the flooding point. Elimination of condenser temperature controls reduces both equipment costs and maintenance.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

*Fractionator Reflux Analog Computer. Trademark, Minneapolis-Honeywell Reg. Co.

Honeywell

H HONEYWELL *First in Control*

NOW YOU CAN STANDARDIZE WITH THE

all purpose power line

(20 TO 1650 H.P. IN ONLY 3 CYLINDER SIZES)

. . . and get all the benefits of GM Diesel standardization in any type of equipment built by over 250 leading manufacturers

Standardization with GM Diesel engines pays off big for oil men because fast-stepping, 2-cycle "Jimmy" Diesels power the finest equipment—get work done faster.

GM Diesel covers the power spectrum—20 to 1650 H.P. with only 3 cylinder sizes—compared to the 5 to 10 cylinder sizes which other Diesel manufacturers use.

Operators who standardize on GM Diesel power need stock, at most, only 3 sizes of wearing parts—maintain full protection with the smallest investment in spares.

GM DIESEL

PARTS AND SERVICE WORLDWIDE

DETROIT DIESEL ENGINE DIVISION, GENERAL MOTORS, DETROIT 28, MICH

In Canada: GENERAL MOTORS DIESEL LIMITED, London, Ontario

Continental-Emsco

D+B HEAVY DUTY STROKE THRU SUBSURFACE PUMPS

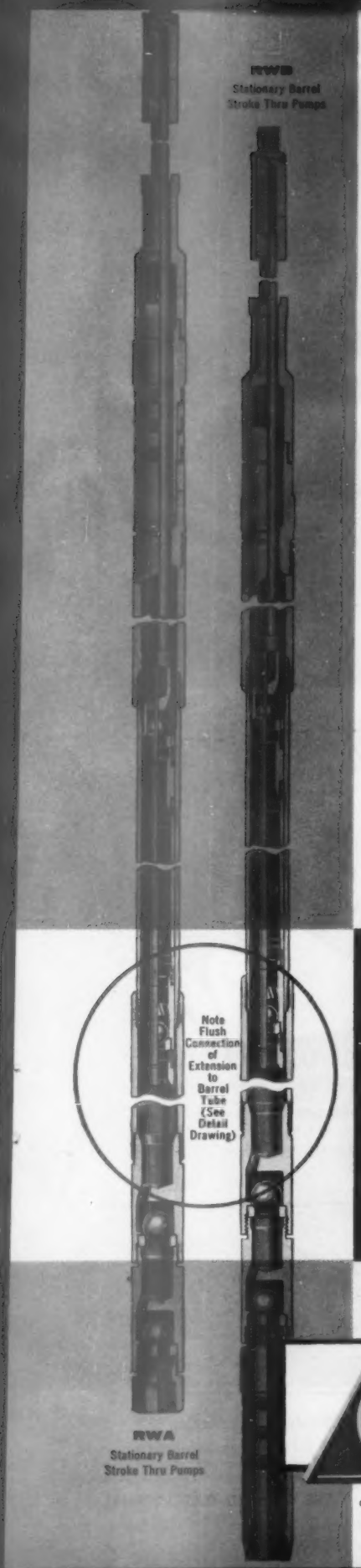
. . designed for pumping deepest wells and wells with severe operating conditions

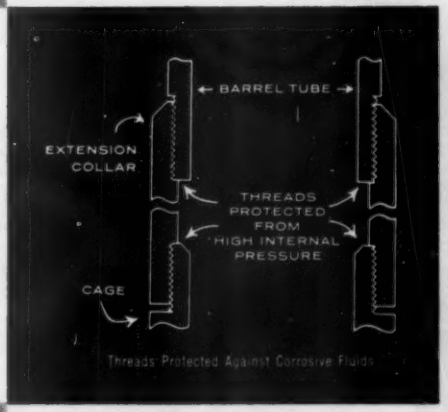
Sand, gyp and paraffin are swept out of the barrel with each plunger stroke in these pumps. This prevents foreign matter from freezing the plunger in the barrel tube. Uniform wear of the *complete* barrel, achieved by the stroke thru design, makes practical the insertion of an oversize plunger for longer barrel life. A regular pump design forms "rings" of unworn metal at each end of the barrel which prevents the use of oversize plungers. D+B Stroke Thru design eliminates this problem.

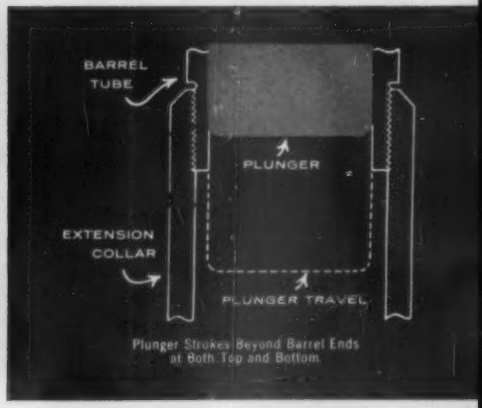
Extension collars make up flush with tube shoulders to cover and protect threads against accelerated failure caused by corrosive fluids. This D+B design also provides greater strength, where high internal pump pressures are encountered.

Extra strength required for deeper pumping is built into these pumps by increasing the barrel tube wall thickness and by simple design. Thicker walls also wear longer in severe abrasive wells, regardless of depth.

D+B Heavy-Duty Stroke Thru pumps are typical of the *designing-for-a-specific-application* that so characterizes D+B engineering concept. Talk to your D+B specialist *first* . . 37 D+B subsurface pump types with over 700 variations give you a wide selection . . a way to more economical pumping.







For Service that Sings . . Equipment that Hums . . Go . .

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Serving the Oil and Gas Industries ... Worldwide

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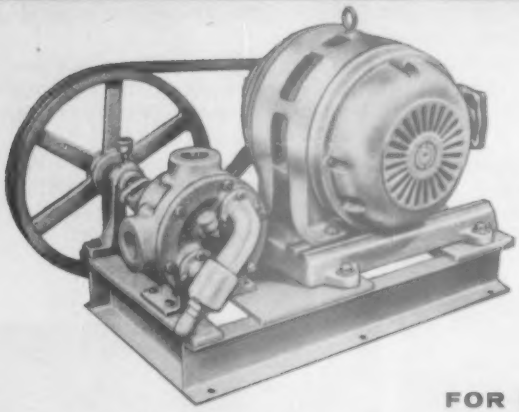
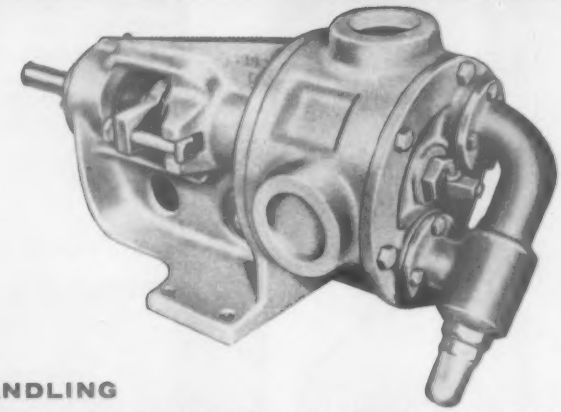
Export Division: 30 Rockefeller Plaza, New York, N. Y. • Continental-Emsco Company Limited • General Offices: Calgary, Alberta, Canada
Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Vert., England • Representatives in All Principal Oil Fields of the World

P902

NOW...FOR GENERAL INDUSTRIAL USE

DEMING ROTARY PUMPS





FOR HANDLING

SOLVENTS • FUEL OILS • LUBRICATING OILS • CHEMICALS • ALKALIES

The complete Deming Rotary Pump line is now available in sizes ranging from ⅜" through 8" for pressures to 200# and capacities to 1050 gallons per minute.

You'll want to know more about the Deming Rotary Pump line! Send today for complete descriptive literature.

The DEMING Co.

903 BROADWAY • SALEM, OHIO

Send me Literature on the Deming Rotary Pump Line.

NAME_____

COMPANY_____ POSITION_____

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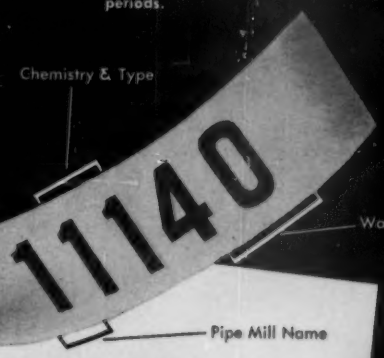
CITY_____ ZONE____ STATE_____

announcing...

Data Tape, Hill-Hubbell's new development, provides simple, positive pipe identification even after prolonged storage periods.



"data-tape"

another first in customer service by Hill-Hubbell

Hill-Hubbell's latest development, Data Tape, will provide more efficient inventory control through *positive pipe identification.*

The Tape is stamped at regular intervals with coded intelligence which identifies the pipe's manufacturer, wall thickness and chemistry. It is spiral-wrapped between the final coating or wrapping and the kraft paper. Hence, at a later date any cut length can be identified by merely tearing back the kraft wrapper far enough to uncover a code marking on the Tape. *Data Tape is available upon request at no extra cost.*

This new development is another assurance of Hill-Hubbell leadership in customer service and long run pipe protection. On your next job specify Hill-Hubbell — the name synonymous with quality in coated-and-wrapped pipe.

Identification of pipe is simple . . . just tear back kraft wrapper until code marking is uncovered on Data Tape.

Coating craftsman points to spiral-wrapped Data Tape which adheres to pipe even after kraft wrapper is removed.

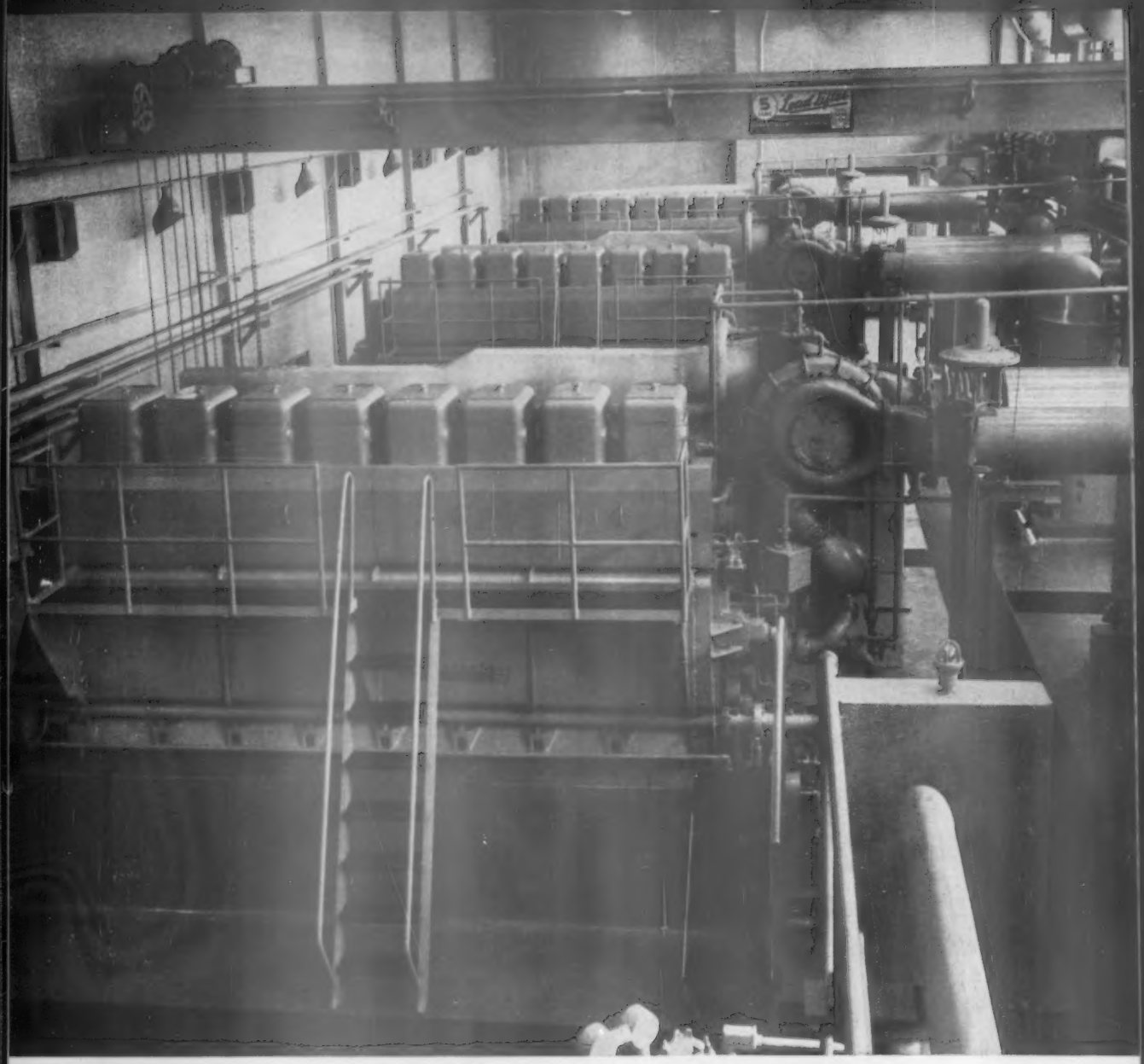
Specify Hill-Hubbell wrapped pipe on your next job . . .

HILL·HUBBELL

DIVISION OF GENERAL PACIFIC CORP.

3091 MAYFIELD RD. · CLEVELAND 18, OHIO · YELLOWSTONE 2-7535

FACTORY APPLICATORS OF COATINGS AND WRAPPINGS



0150

Pipe line engines by Nordberg

Nordberg engines are a sound investment in long term pipe line power.
Consult Nordberg on your crude, products or gas pipe line programs.

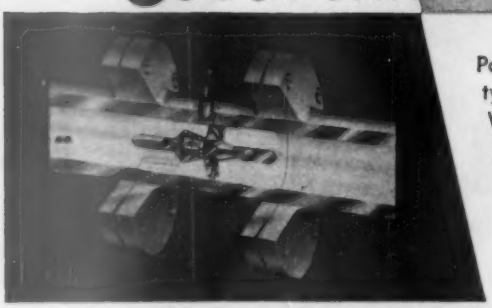
NORDBERG MANUFACTURING COMPANY
MILWAUKEE 1, WISCONSIN

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS
NEW ORLEANS • NEW YORK • ST. LOUIS • SAN FRANCISCO • TAMPA
WASHINGTON • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO D. F.

ELECTRONIC, TURBINE-TYPE POTTERMETERS SERVE INDUSTRY APPLICATIONS RANGING FROM

0.1 g.p.m. to 60,000 b.p.h. or more

Cost? *LOWEST FIRST COST... LOWEST UPKEEP!*



Pottermeter utilizes a hydraulic principle to suspend its turbine-type rotor in an axial "floating" position. No thrust bearing. Without thrust friction, the rotor responds instantly without slippage at a spin-rate governed by, and accurately proportional to, the velocity through the pipe. An Alnico magnet in the rotor produces an electric signal which operates readout or control equipment as required for indication, recording or automation. Compared to positive displacement meters, relative simplicity, freedom from wear and smaller size cuts costs, especially for higher capacity requirements.

Potter-Bowser engineers gladly confer with petroleum system engineers on invitation to provide detailed information on metering equipment to meet exact requirements.

CHECK THESE ADVANTAGES OF THE POTTERMETER

- ✓ 1 MOVING PART
- ✓ PRESSURES, Unlimited
- ✓ TEMPERATURES, −455°F. to +1500°F.
- ✓ STANDARD CONSTRUCTION, Type 316 stainless steel
- ✓ ELECTRONIC READOUT EQUIPMENT, To specifications
- ✓ FRICTIONAL RESISTANCE, Virtually nil
- ✓ STOP-START, Instantaneous
- ✓ ACCURACY, Unexcelled

pottermeter

PETROLEUM ENGINEERS:
Contact Potter-Bowser Division at address below for prompt information and data service.

BOWSER MARKETING DIVISION
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FORT WAYNE, INDIANA

Just a wavelength from ANYWHERE . . . via AIRCOM
Why Philco has been selected to modernize the world's largest communications system
AIRCOM is the vast, global network of electronic communications that links every base, outpost and aircraft of the U. S. Air Force. It is the world's most extensive integrated communications system.
Recently awarded the contract to modernize and expand AIRCOM, Philco was selected by the Air Force for its proven ability in systems management and its extensive experience in global communications.
The modernized AIRCOM System will utilize advanced techniques in both point-to-point and air-to-ground communications. It will provide greater traffic capacity, maximum reliability and complete compatibility of all USAF communications equipment.
In the world of advanced electronics . . . in communications, data processing, missiles, satellites, weapons systems and radar . . . look ahead and you'll choose Philco.
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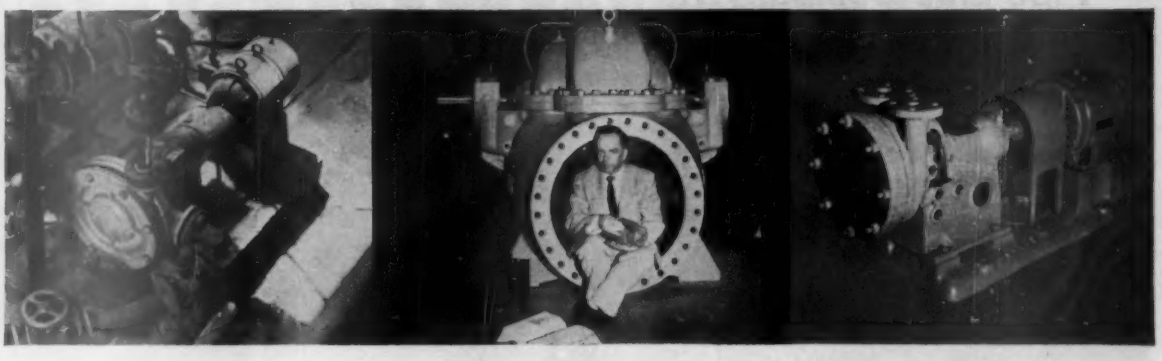
GOVERNMENT & INDUSTRIAL DIVISION
4700 WISSAHICKON AVE., PHILADELPHIA 44, PENNA.

PUMPAGE

Goulds' news about pumps for process industries



Idea from a cosmetic bottle

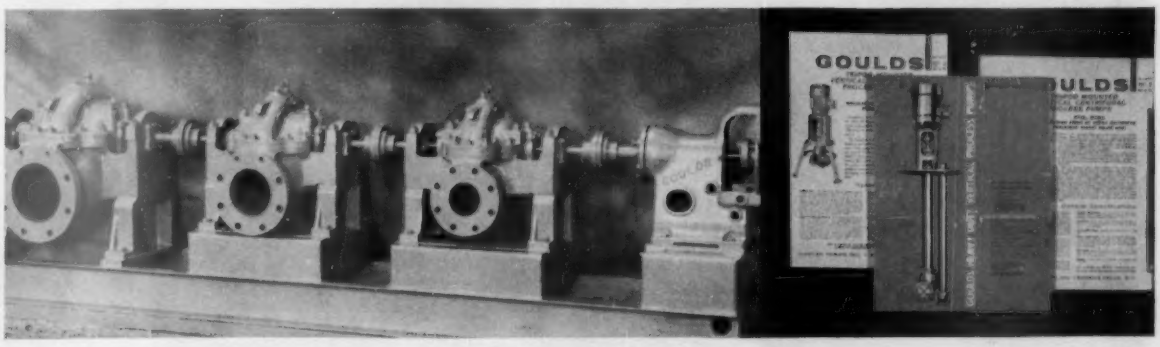
Cold wave lotion made from Evans Chemetics' thioglycolic acid comes to consumers in a bottle. A *glass* bottle. That set Evans to thinking: if *glass* prevents contamination in packaging, why can't it do the same job in *processing?* So they installed a Goulds-Pfaudler *glassed* pump. In it, glass is permanently fused to metal at every surface that contacts the pumpage. Result? Where expensive alloys were required to prevent contamination during processing, now smooth *glass* does the job . . . *better!* Maintenance and replacement problems ended too—for a full year after installation! Write for Bulletin 725.2.

Largest and smallest

The man dwarfed by the giant pump is a Goulds Application Engineer. Look closer. He's holding another pump, small enough and light enough to be held in one hand! His assignment: select the right pump for *your* specific need from all the pumps that fall within the range of Goulds' largest and smallest pumps. For instance—want to move a *lot* of liquid *fast?* That big job does it at *40,000 GPM!* Need a small, stainless steel pump that you can use 24 hours a day for chemical circulating or transfer work? Get as little as 1 GPM with the little pump. Cut pumping costs with the *right* pump for your job.

Pump with a built-in "steam bath"!

When fat is a problem—try a steam bath! The steam bath we're speaking of keeps fats, wax, paraffin and other low-melting point solids *fluid* in your pumping system. It's "built-in" on the Goulds Fig. 3715 chemical pump to maintain high process temperatures—right at the pump. A steel steam jacket of full casing diameter keeps *all* the liquid in the pump hot. Can be furnished with new, or added to existing, pumps. You pump low melting point fluids or saturated salt solutions without "freezing"—to reduce down time in your operation. Write for Bulletin 725D17.



Tandem-mounted pump idea

Here's where it might pay you to put all your eggs in a single basket! One oil refiner set up four Goulds pumps *in tandem*, powered the whole works with one steam turbine. Advantages? The combined total horsepower allowed selection of a more efficient large turbine with reduced steam consumption—plus eliminating 3 turbines, bases and foundations. The two Goulds Fig. 3405 pumps in the center handle rich oil at 300 and 375 GPM respectively, with heads of 211 feet. At the left is a Goulds Fig. 3405 that pumps 600 GPM of lean oil at 248 ft. head. Pump on the right is a Fig. 3755 for supplying still reflux at 155 GPM and a head of 149 feet. All pumps and the turbine are mounted on a common steel base.

News about vertical process pumps!

Here's a complete rundown on what's new with heavy-duty vertical process pumps for handling corrosive liquids in the chemical process and allied industries. In many applications in the process field, the use of vertical pumps for transfer or other services offers many advantages. Advanced design provides for wet pit, dry pit and tripod-mounted pumps with maximum interchangeability of parts. These booklets list them all—and they're yours *free*. Just send to Goulds for your copy. Write Goulds Pumps, Inc., Dept. OG-99, Seneca Falls, New York.

GOULDS PUMPS

Michigan Wisconsin Pipe Line Company...

loops for

larger volume

374 miles of looping spans midwest...swells main line capacity for average day by eighty million cubic feet of natural gas

During July, Wisconsin and Michigan gained an added eighty million cubic feet of natural gas daily — through new loops paralleling Michigan Wisconsin Pipe Line Company's main line. Between the Laverne field in Harper County, Oklahoma, and the W. G. Woolfolk Station near Big Rapids, Michigan, 374 miles of 24-inch pipe were laid — all furnished by *A. O. Smith*.

For almost 30 years . . . A. O. Smith line pipe has always been manufactured to a high standard of quality . . . precisely controlled at every step of production. That's why A. O. Smith pipe, made and installed in 1928, is still in operation. That's why so much A. O. Smith pipe is found in every important pipeline project.

Through research . . . *a better way*

A.O.Smith

CORPORATION

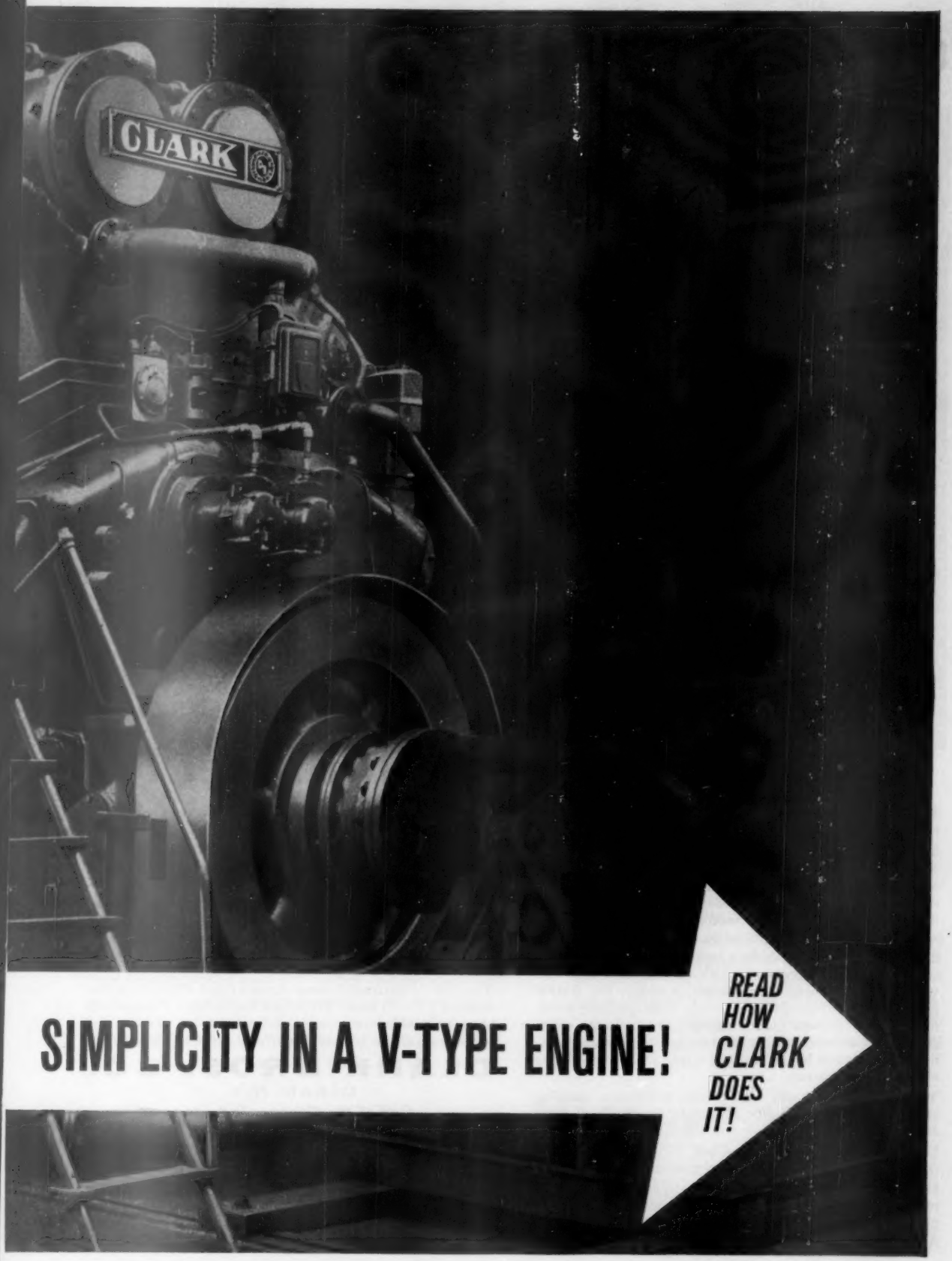
TUBULAR PRODUCTS DIVISION

Milwaukee 1, Wisconsin

Chicago 3 • Dallas 35 • Houston 2 • Los Angeles 17 • Midland 5, Texas • New Orleans 12
New York 17 • Tulsa 3 • A. O. Smith INTERNATIONAL S. A., Milwaukee 1, Wis., U. S. A.

FOR PIPELINE BOOSTER STATIONS...

2-CYCLE DEPENDABILITY, 2-CYCLE


CLARK
SIMPLICITY IN A V-TYPE ENGINE!
READ HOW CLARK DOES IT!

Clark Presents the TPV... 2-Cycle, Turbocharged, V-Type Gas Engine

MORE POWER
GREATER DEPENDABILITY

This is the TPV – the Clark answer to the challenging need for greater dependability and availability in pipeline engines.

Several years in development, the turbocharged, 2-cycle TPV gas engine packs huge amounts of horsepower into a compact, rugged, V-design. Even more important, it features the same dependability, simplicity and low maintenance inherent in all Clark 2-cycle machines.

Many major features and components have already been thoroughly field proved in the Clark TLA gas-engine-driven compressor. For example, the TPV has the same bore and stroke, the same basic turbocharger, a similar low BMEP rating. Compared to other engines with high operating stress, the TPV has unusual reserve capacity to handle the emergency peak demands encountered on gas transmission pipelines. At normal loads, the low stress factor eliminates excessive maintenance.

You'll save in every way – initial cost, installation, housing and operating expense. For conclusive proof, check these exclusive benefits to you:

UP TO 40% LESS PARTS – Clark 2-Cycle simplicity and reliability cuts replacements to a minimum.

UP TO 33% LOWER BMEP – Rugged Clark construction plus low operating stress (110 BMEP) mean far longer life plus unusual reserve capacity.

APPROXIMATELY 40% THERMAL EFFICIENCY

WIDE, SAFE SPEED RANGE – No dangerous harmonics in the 250-360 rpm range. Permits wide loading flexibility.

MAINTENANCE DRASTICALLY REDUCED – Lower frame loading, lower piston speeds, fewer plug changes, less lube oil contamination, no large intake or exhaust valves.

The Clark 17" x 19" TPV is built in three sizes – 10, 12 and 16 power cylinders with ratings of 4000, 4800 and 6400 bhp.

NOW GET THE WHOLE STORY. Consult your nearest Clark Office or write to Clark Bros. Co., Olean, N. Y.

The TPV-10 illustrated above shows a Clark 4000 bhp turbocharged TPV-10 under test at the Clark factory. This unit will soon be installed on a major gas transmission pipeline and will drive a Clark 24 x 24 Centrifugal Pipeline Compressor.

CLARK BROS. CO.

OLEAN, N.Y.

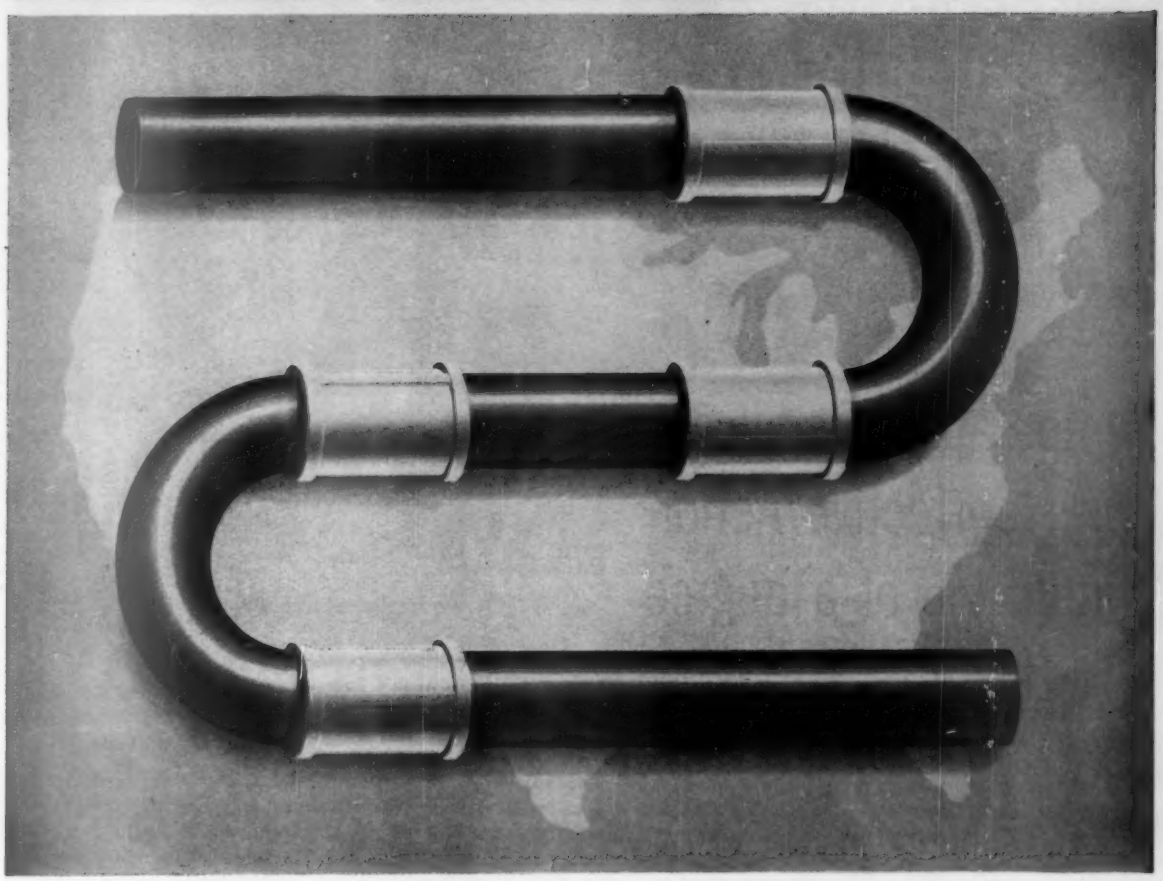
One of the Dresser Industries

CLARK®

ONE OF THE DRESSER INDUSTRIES

ENGINES • COMPRESSORS • GAS TURBINES

Naugatuck KRALASTIC



9,000 miles of evidence...
KRALASTIC pipe is superior!

Count it by the mile or by the inch, the amount of KRALASTIC® pipe already installed—for everything from drinking water service to salt water disposal, from oil, gas and chemical lines to underground electrical conduit—offers convincing evidence of this superior pipe material's many advantages.

The record of those 9,000 miles of KRALASTIC pipe installed proves KRALASTIC's outstanding virtues. Proves the lasting properties of KRALASTIC. Proves the versatility of KRALASTIC. Proves KRALASTIC's extreme ease of installation. Proves its ability to take all kinds of weather, from extremes of Tropic heat to the depth of Arctic cold.

Benefit from the experience of the hundreds of users who have proved the unique advantages of KRALASTIC pipe. Investigate this superior plastic piping material yourself. Write for your free copy of the KRALASTIC story—"9,000 miles of KRALASTIC pipe".

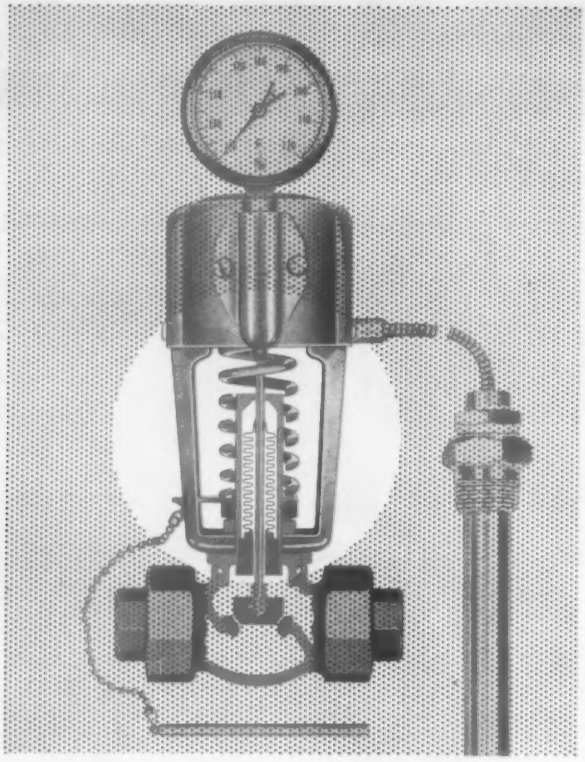
US RUBBER

United States Rubber
Naugatuck Chemical Division
916 K ELM STREET
NAUGATUCK, CONNECTICUT

KRALASTIC RUBBER-RESINS • **MARVINOL** VINYLS • **VIBRIN** POLYESTERS

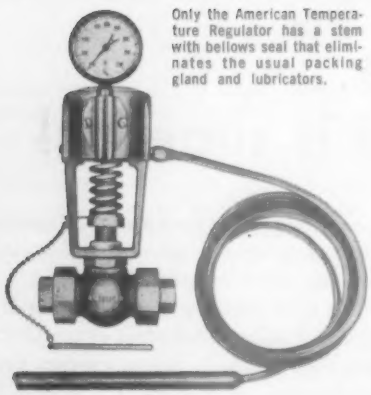
Akron · Boston · Gastonia · Chicago · Los Angeles · Memphis · New York · Phila. · CANADA: Naugatuck Chemicals · Elmira, Ont. · Cable: Rubexport, N.Y.

Temperature Regulation with Corrective Action within 1/10 of a degree



A friction-free bellows seals off the valve stem on the new American Temperature Regulator. Result: no stem binding to retard valve action, fastest possible temperature response.

The bellows seal makes practical a friction-free, nonleaking packless valve that needs no lubrication. This innovation plus an extra-long, preflexed adjusting spring marks the new American Temperature Regulator as the fastest acting, most stable available. Corrective action starts at less than 1/10 degree change at the bulb. And the adjusting spring allows unusual latitude in temperature settings.



Only the American Temperature Regulator has a stem with bellows seal that eliminates the usual packing gland and lubricators.

Compact design permits installation in "tight" locations. The dial thermometer on the indicating-type regulator can be positioned for easiest reading regardless of piping arrangements. Standardized parts and unitized assembly mean low initial cost. Maximum feasible use of stainless steel and a minimum number of components eliminate maintenance problems.

Get the best in economy, accurate temperature regulation, and dependability. Choose American Temperature Regulators. *Sizes:* ½" to 1½". *Temperature Ranges:* As low as minus 15°F. to 50°F.—as high as 240F°. to 350°F. *Valve:* Bronze body, stainless steel seat and disc. *Ask for Bulletin 114A.*

Phone your industrial supply distributor for counsel, service and prompt delivery from his local stocks.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

AMERICAN TEMPERATURE REGULATORS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

New AN AUTOMATIC, COMPACT **LimiTorque**

...FOR OPERATING YOUR

Plug Valves

...IN 8 TO 16 SECONDS

LimiTorque LINEAR MOTORIZED VALVE OPERATOR

...a dependable time, labor and money saver

Another LimiTorque *first* — here's the answer to the problem of motorizing your wrench (hand) operated Plug Valves . . . a simple, easily installed unit that can be built either to NEMA IV (weather-proof), or NEMA VII (explosion-proof) standards . . . an inexpensive, sturdy, fully reliable and extremely compact assembly that requires no gear changes or modifications, other than to supply a motor with the proper output speed. The *LimiTorque Linear Operator* consists of motor and double reduction gearing which drive a traveling screw and a crank that is easily mounted to the square shank of plug valve.

As noted in the illustrations, the entire assembly can be readily adapted to your plug valve while in service, by merely mounting the crank on the plug shank and strapping the support bracket to the pipe . . . The *Linear Operator* is supplied with all necessary adapting parts such as the support bracket and straps for mounting on the pipeline; also the necessary crank arm for mounting on the square shank of valve plug — The entire construction and operation is indeed simple . . . and the purchase price and installation costs are comparatively low.

A torque of 175# is developed at the valve, which is normally more than enough to drive most wrench-operated plug valves up to 6" in size. If power fails, or manual operation is desired, the mere removal of a pin (which connects the traveling screw to the crank arm) will divorce the crank from the *Linear Operator* assembly — and a bar placed in the bushed bore of the crank arm will operate the valve. (No special wrench is needed.) The mere flick of a switch to the direction of travel desired will operate the valve . . . Contact your valve manufacturer, or your nearest LimiTorque Sales Engineering Office.

Full details on this *new LimiTorque Linear Operator* are contained in Bulletin 20-58 . . . send for copy on your business letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS
LIMITORQUE VALVE CONTROLS
FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

MEMO TO PIPELINERS:
If you are really interested in the newest and most advanced method of cleaning gas, Ask Peerless about these installations.
PROVEN PEERLESS SCRUBOSPHERES FEATURE
• Newest Design
• Lower Initial Cost
• Cleaner Gas
• Lower Maintenance Cost
• Wide Customer Acceptance
PEERLESS MFG. CO.
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PEERLESS MANUFACTURING CO.
P. O. BOX 13165 • DALLAS, TEXAS
Representatives in All Principal Cities
21,000
OVER 21,000 SEPARATORS and SCRUBBERS IN SERVICE

ALLIED CHEMICAL'S HOTLINE ENAMEL SOLVES HOT-SIDE PROBLEMS

Allied Chemical's Hotline Enamel takes high temperature punishment from the hot-side of compressor stations . . . for years! Allied Chemical's Hotline Enamel won't crack at −10°F.—as proved in laboratory tests and on-the-job performance for leading public utility companies.

Allied Chemical's *Job-Matched* Hotline Enamel is derived from coal-tar pitch, thus possessing inherent protective properties against the damaging effects of water, soil chemicals and electrical currents. In addition to these properties, Hotline Enamel is bargain rated both for initial cost and long-run service.

Provides improved protection under all these specific conditions:

1. Hot gas pipelines, on discharge side of compressor stations where line temperature is above 120°F.

2. On pipe-type cables or "oil-o-static lines" which are subject to internal electrical heat from high-voltage surges.

3. Warm, swampy areas or other places where excessive soil stress on pipelines is encountered.

4. Areas where backfill and trenches are rough, rocky or contain foreign objects which normally penetrate softer coatings.

5. Pipelines (such as heated fuel lines) where temperatures are consistently high most of the time. but do not exceed 180°F. or for short-term exposure, 200°F.

A staff of Field Service Experts are at your call to offer you technical assistance that can save you maintenance time and costs.

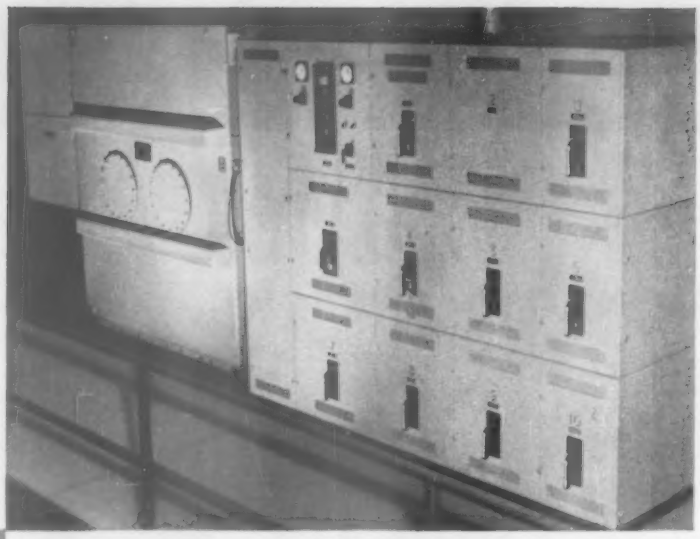
PLASTICS AND COAL CHEMICALS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical

Wagner

SEALED DRY-TYPE TRANSFORMERS

These modern unit substation transformers can be safely installed in any load-center—any place—because they are hermetically sealed in welded steel cases to provide positive protection from contamination, fire and explosion hazards. The only maintenance needed is periodic checking of gas pressure (inert nitrogen), case and bushings.



Here's Reliable Power

for your plant electrical system

WAGNER LOAD-CENTER TRANSFORMERS

Wagner

INDOOR DRY-TYPE TRANSFORMERS

These new quiet-type transformers are compact, light in weight, provide a flexible, modern power system to change higher voltage distribution service to lower voltage lighting and power circuits. They meet all safety requirements for indoor installation.

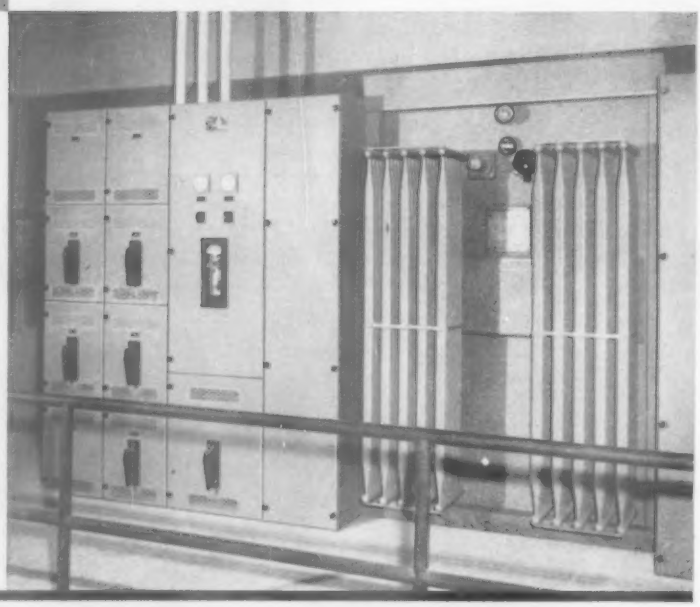
Wagner

NOFLAMOL TRANSFORMERS

Non-inflammable liquid filled. For indoor or outdoor installation. Close-coupled design fits flush against switchgear enclosures, to eliminate and save space. Throat-connected designs are also available.

Bulletins TU-205 and TU-214 give full information on Wagner Load-Center Transformers. Write today.

WT59-2



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Wagner Electric Corporation

6389 Plymouth Ave., St. Louis 14, Missouri.

SERVING 2 GREAT GROWTH INDUSTRIES . . . *ELECTRICAL . . . AUTOMOTIVE*

Nationwide stocks give you prompt delivery...

on CF&I-CLAYMONT HEADS

This giant steelman – the Image of CF&I – represents *service* for CF&I customers coast to coast. One example of this service is the inventory of Claymont Steel Head stocks maintained at strategically-located CF&I warehouses.

Elliptical Heads are stocked at Houston • Los Angeles • San Leandro, Calif. • Tulsa

Inside Diameters–24" to 120"
Specifications–A-285-C and A-212-B Firebox Steels

ASME and Standard Flanged and Dished Heads are stocked at Chicago • Claymont, Del. • Houston • Tulsa

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Specifications – ASTM A-285-C Flange and Firebox Steel; Hot Pressing Steel (for Standard Heads only)

Fittings are stocked at Chicago • Claymont, Del. • Houston • Tulsa

Manhole and Handhole Fittings • Elliptical Manhole Rings for Low Pressure Vessels • Storage Tank Manhole Frames and Covers

Claymont is completely equipped to produce spun or pressed heads in diameters from 9" to 19'...in gages from 3/16" to 6"...in all shapes and a complete range of ferrous and non-ferrous metals.

Complete details on Claymont Head stocks are published and distributed monthly. If you are not now receiving this stock list, and would like to, just notify the CF&I sales office nearest you.

CF&I-CLAYMONT PRODUCTS: Carbon Steel Plates • Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Clay-Loy High Strength Low Alloy Steel Plates • Flanged and Dished Heads • Pressed Steel Shapes • Manhole Fittings, Covers and Saddles • Fabricated Steel Plate Products • Large Diameter API Pipe

Claymont Steel Products

THE COLORADO FUEL AND IRON CORPORATION

CF&I STEEL

In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso • Farmington (N. M.) • Ft. Worth • Houston • Kansas City Lincoln • Los Angeles • Oakland • Odessa • Oklahoma City • Phoenix • Portland (Ore.) • Pueblo • Salt Lake City • San Francisco • San Leandro • Seattle • Spokane • Tulsa • Wichita
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7085-A

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

313 WILSON, SO. NORWALK, CONN.

from the makers of Dimetcote...

ZINKOTE®

THE FIRST 100% INORGANIC *SELF-CURING* ZINC COATING.

- A radically new concept in zinc coatings for protecting steel.
- Under development for many years and first patented in 1957.
- Applied in one coat – completely self-curing.
- Can be used wherever galvanizing is satisfactory – actually gives superior protection.
- Completely nonflammable, nontoxic.
- Insoluble in all petroleum products.
- Outstanding resistance to weathering, salt and fresh water.
- Applied by brush, spray or roller.
- Cathodically protects steel.
- Resists temperatures up to 600°F.
- Complete protection for as little as 5¢ per square foot material cost.

For complete information write . . .

How does Zinkote compare with Dimetcote?
Although similar, each has certain unique advantages depending upon the particular requirements of the job. We will be glad to give you a specific recommendation.

Amercoat® CORPORATION

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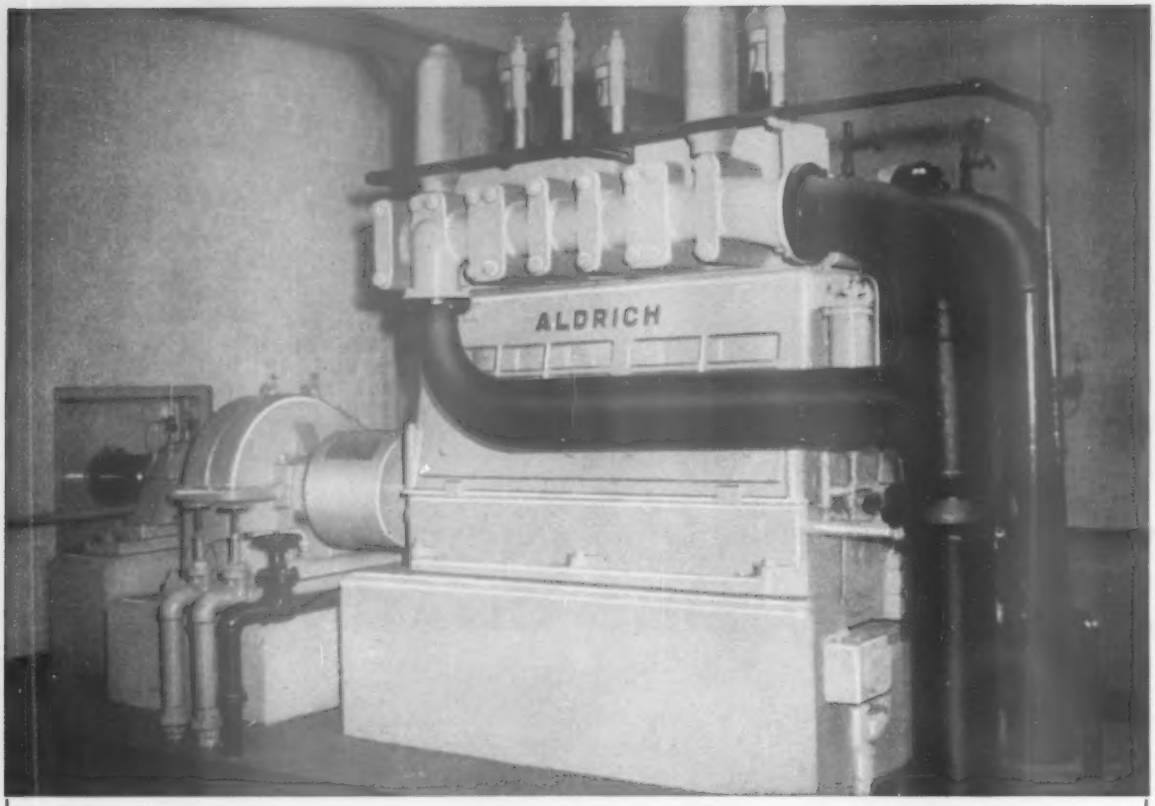
The Pioneer Manufacturer of Inorganic Zinc Coatings

119



FIELD REPORT

APPLICATION: Pipeline Service

South Saskatchewan Pipe Line Company, Cantuar, Saskatchewan.

PUMPS: 3 Aldrich Quintuplex,

4½" plungers, 6" stroke. Each having a capacity of 20,000 b/d at 300 RPM, 1200 pounds pressure.

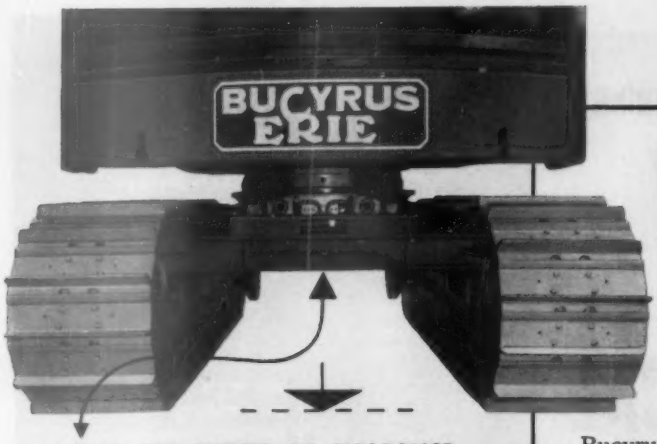
OPERATION STARTED: December, 1955

EXPERIENCE TO DATE:

Units pump viscous crude oil over 158 miles of 16" main line pipe. Customer reports exceptionally fine field service with routine maintenance only.

Field parts stock available in Carmi, Ill.; Charleston, W. Va.; Casper, Wyo.; Houston; Los Angeles; Odessa and Tulsa. For further information, write the Aldrich Pump Company, 9 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH



21 ¼ BIG INCHES OF CLEARANCE

Hi-Walkers move right over rock and dirt that foul up many a rig because they have more clearance than any other hoe this size (¾-yd).

Hi-WALKERS

...Rigs with a Record!

Bucyrus-Erie Hi-Walkers have the clearance and the design features that keep them moving, give a big lift to spread schedules, regardless of the tough going.

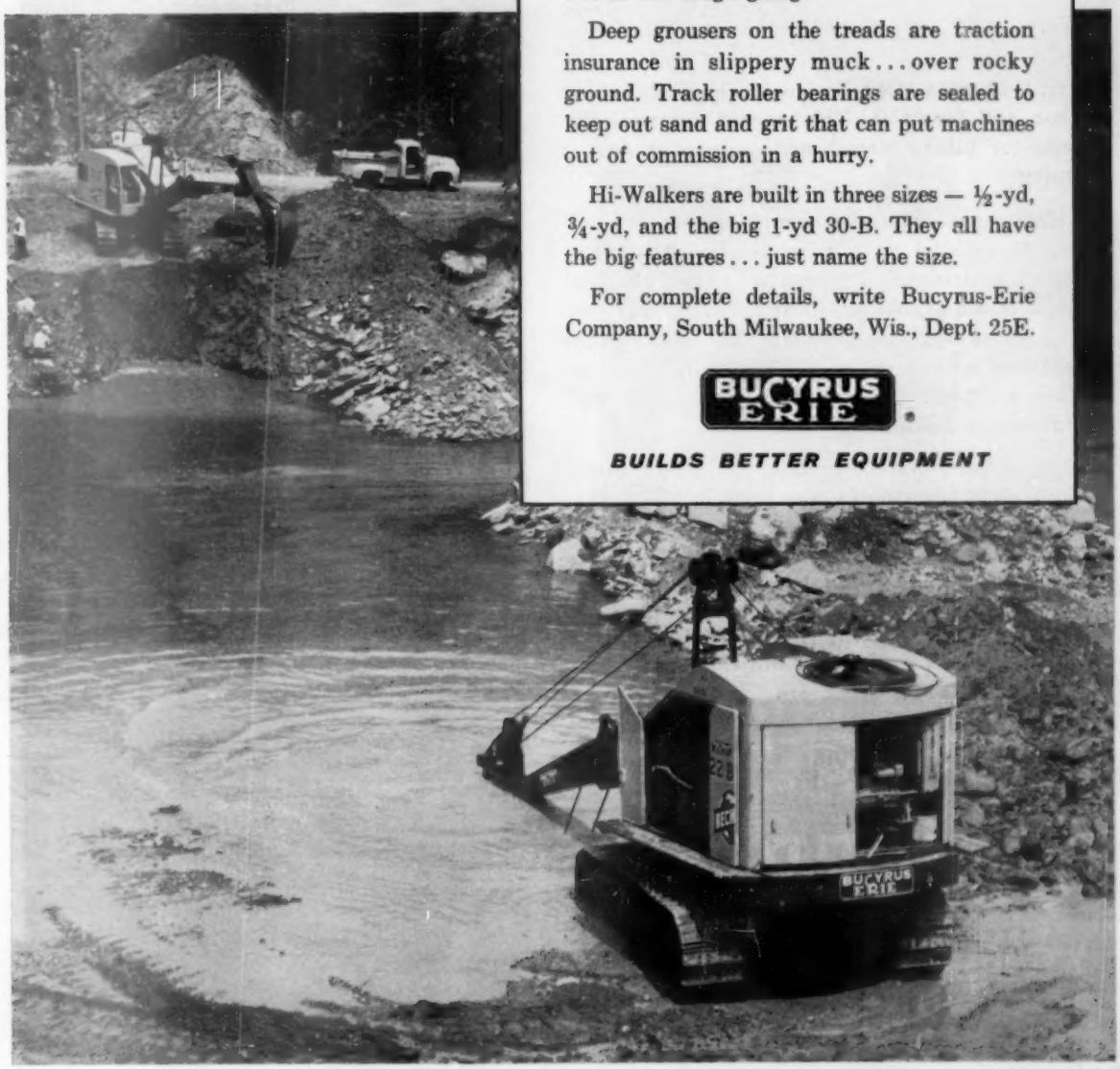
Deep grousers on the treads are traction insurance in slippery muck... over rocky ground. Track roller bearings are sealed to keep out sand and grit that can put machines out of commission in a hurry.

Hi-Walkers are built in three sizes — ½-yd, ¾-yd, and the big 1-yd 30-B. They all have the big features... just name the size.

For complete details, write Bucyrus-Erie Company, South Milwaukee, Wis., Dept. 25E.

BUCYRUS ERIE

BUILDS BETTER EQUIPMENT



AUTOMATICALLY STOP TUBING BREATHING
and* BUCKLING . . *safely* . . *efficiently

GUIBERSON HM2 HYDRO-MECHANICAL TUBING ANCHOR

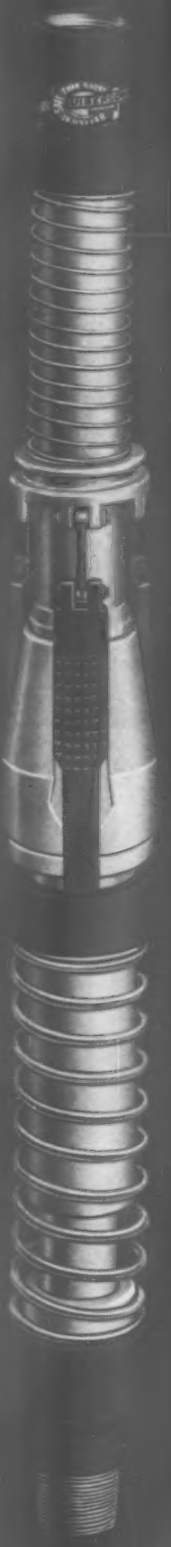
Install Guiberson HM2 Hydro-Mechanical Tubing Anchor and forget it. This anchor automatically adjusts for tubing stretch and contraction during pumping.

The HM2 is a *mechanically* operated anchor. A heavy spring keeps slips in a retracted position. When pumping, a pressure differential across the tool causes a piston to counteract the heavy spring; and, the upper spring mechanically forces slips into engagement with the casing. The piston then becomes a *static* seal; and thereafter, adjustments to well conditions are automatic.

Anchor moves freely down hole on pump's down-stroke . . automatically sets on upstroke. Tubing is held at its lowest level to prevent buckling and breathing for maximum pumping efficiency. Shear ring protects tubing from excessive tensile loads.

Install Guiberson HM2 Hydro-Mechanical Tubing Anchors and Start Pumping at Top Efficiency.

Sold by Oil Field Supply Stores Everywhere



Fluid rising in tubing automatically sets anchor . . no surface manipulation required.

Anchored tubing prevents tubing and casing friction damage.

Dovetail head and slips insure smooth, safe operation.

Generous by-pass areas assure safe running — retrieving.

Design prevents hydraulic pressure in tubing from loading shear release.

Anchor is released by straight pull shear release or tubing manipulation.

Shear release causes an upward jar to disengage slips . . . lowering tubing string to release anchor is not necessary.

THE
GUIBERSON
CORPORATION
ESTABLISHED 1919
DALLAS, TEXAS U. S. A.

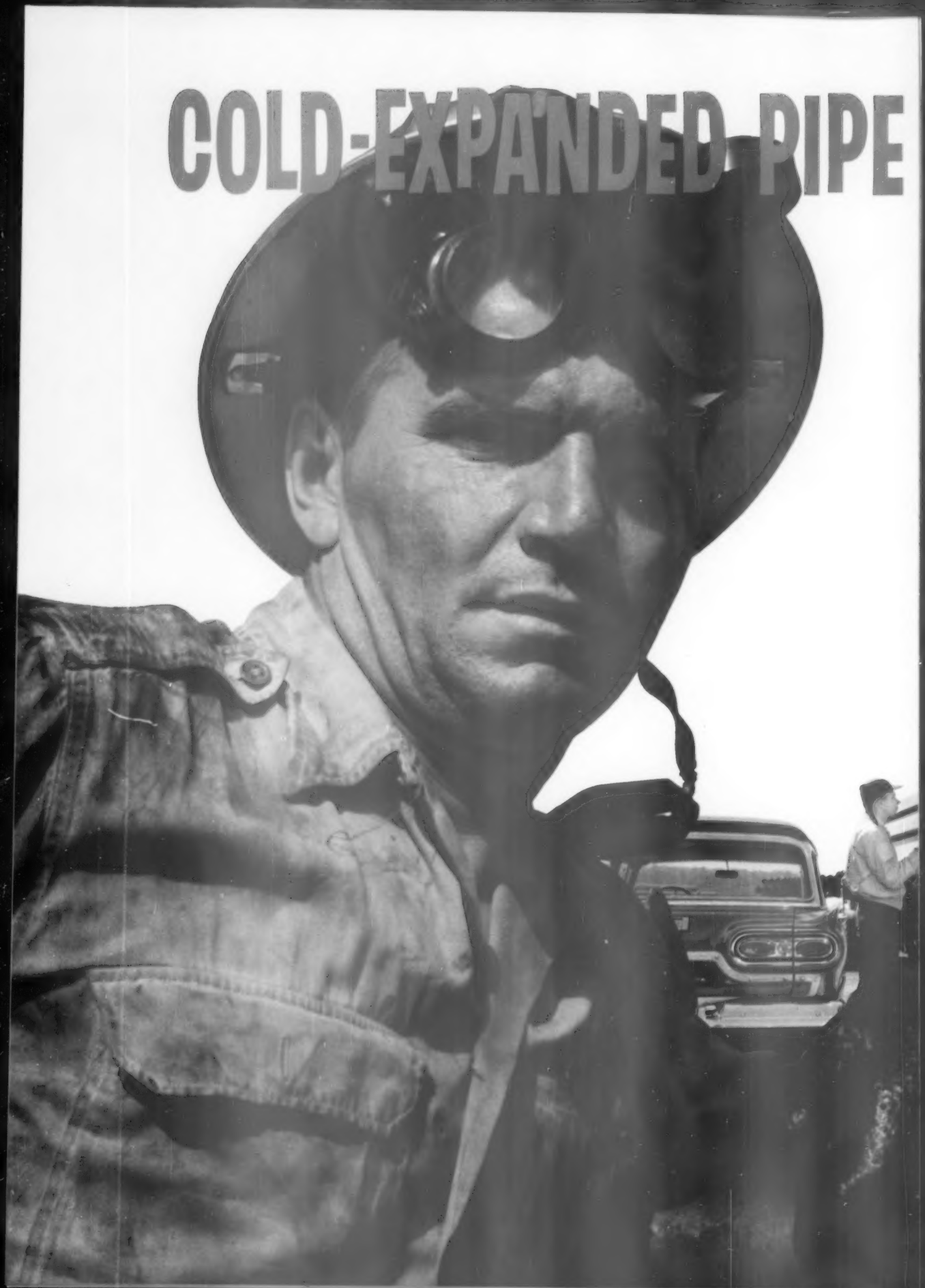
This oilwoman waits for a telephone ring that can bring the desert to life.

She's part of the huge oil communications network, proud to be in an industry that is helping the desert to bloom. Example: the Four Corners area, where Utah, Arizona, Colorado and New Mexico meet. Here, wastelands are pulsing with new life and industrial vigor—because of oil. The next time you hear somebody speak out against oil—tell him you're an oilman and glad of it. And tell him why.

SHELL OIL COMPANY

SHELL

COLD-EXPANDED PIPE

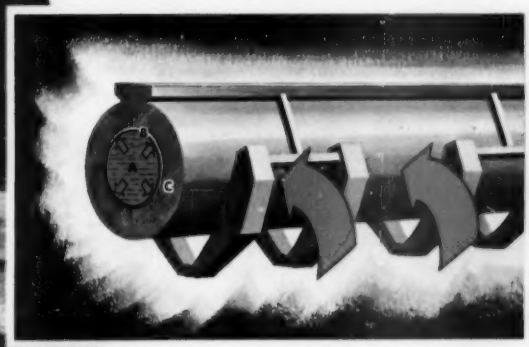


MEANS HIGHER STRENGTH

Youngstown Electric Weld Line Pipe is cold-expanded for higher strength. It lines up fast, lays fast to keep your construction costs low. This is why you'll find Youngstown pipe in so many major lines.

Remember, Youngstown Electric Weld Line Pipe is hydrostatically expanded to uniform roundness. In this operation (see below), internal water pressure (A) forces the pipe (B) outward against the solid walls of a mantle (C). Cold-expansion provides a lighter, stronger pipe for carrying higher line pressures. As a result of this process, cold-expanded line pipe has increased field weldability.

For particulars about Youngstown Electric Weld Line Pipe, contact our sales and field engineering offices strategically located throughout the oil and gas-producing country. The Youngstown Sheet & Tube Company, Youngstown 1, Ohio.



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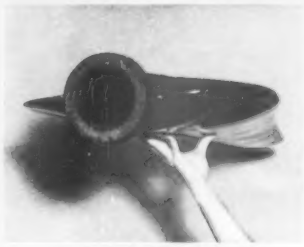
ELECTRIC WELD LINE PIPE



Lightweight.

Easy installation and adjustment.

NEW HUDSON TUF-LITE FANS

After six years of development work and tests of trial field installations operating under wide ranges of conditions in cooling towers, finned tube coolers, and in highly corrosive chemical plant ventilating service, Hudson presents a new product—the TUF-LITE fan. The blades, cast in one seamless piece of fiber glass reinforced synthetic resin, are hollow, light and tough. TUF-LITE fans afford the following advantages over any other available type of fan:

SAFE: TUF-LITE blades being lightweight (about ¼ the weight of other blades with comparable capacity) and infrangible, eliminate the hazards to personnel and equipment existent through accidental throwing or disintegration of heavy metal, wood, or laminated blades while in service.

EFFICIENT: More air is moved at less horsepower because weight and finishing operations do not impose limitations on selections of best aerodynamic design; therefore nearly ideal airfoil cross sections, commercially attainable only in TUF-LITE blades, can be used. Blades will not sag or distort, and surfaces remain permanently smooth.

LOW MAINTENANCE: TUF-LITE blades are unaffected by corrosive, abrasive or impingement effects of hot saturated air, sand, rain, or hail, and have superior deterioration resistance to practically all corrosive vapors or liquids. Blade materials contain color pigment; no painting is necessary. Light weight reduces stress and maintenance on bearings, gears, drive shafts, and supports.

QUIET: The permanently smooth surfaces, very light weight, sustained perfect balance, and advanced aerodynamic design minimize noise.

EASE IN INSTALLATION: Light weight of blades and ingenious design of hub and blade coupling allows attachment of blades by one man using only small wrench. Coupling design assures uniformity of pitch of all blades, and as blades of same size are identical and interchangeable, perfect fan balance is preassured.

In replacement of present fans or in installations on new cooling equipment of any manufacture TAKE ADVANTAGE OF THE OUTSTANDING SUPERIORITY OF HUDSON TUF-LITE FANS.

Bulletin on TUF-LITE FANS
Available upon Request

TUF-LITE protected by U.S. copyrights, patents and patents pending

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They Say—

Death report exaggerated

Dear Sir:

I have been following the post-obituaries in The Oil and Gas Journal regarding the deaths of the various scout checks throughout the country when the new scouting services go into effect this fall and was very surprised to learn that the Dakota Oil Scout's Association located in Bismarck was "one to be most seriously affected and that possible maximum attendance be cut to three or four scouts, making meetings impractical."

Sir, we would like to take this opportunity to inform you of the fact that the six companies who have subscribed to the new Well Record Service account for less than half of our present attendance in our check meetings and that the remaining nine companies have not thrown up their hands in confusion and despair but will continue to participate in check as we have in the past.

This letter is to inform you and the industry of the fact that the Dakota Scout Check will not fold up on October 1 and, in my opinion, will continue to operate for a long time to come.

Berk Strothman
President
North Dakota Oil Scouts
Association.

Beneficial and enlightening

Dear Sir:

I would like to compliment Robert Enright on his excellent coverage of the Conservation Forum's spacing campaign (Aug. 31, p. 36).

I think the article is well written and clearly sets forth our objectives. The fact that we are making some progress is evidenced by the remarks that General Thompson made in his speech at the Oil Centennial celebration in Titusville, Pa. Contained in his speech was the following statement:

"With broader spacing of wells we have made it possible to keep up the reserves without drilling so many wells. Forty-seven thousand wells per year drilled today do the work of 58,000 wells in the years past. Broader spacing is a necessary improvement to prevent unnecessary waste and keep petroleum products cheap. Of course, closer drilling can be had later on if found necessary."

I am sure that articles like yours

will have a beneficial and enlightening effect.

E. B. Miller, Jr.
Vice President
Tidewater Oil Co.
Houston.

Good ol' days are gone

Dear Sir:

The precedent-breaking announcement of the Standard Oil (N.J.)-Carter-Humble reorganization, coming recently on the heels of a similar reorganization of Mobil-General Petroleum-Magnolia is a very significant turning point in domestic oil history and should not be underestimated.

When Gulf Oil Corp. made its RIF (reduction in force?—ed) January 1, 1957, followed a year later by Phillips Petroleum Co.'s RIF in domestic oil exploration, with a series of other RIF's in 1958, the fat was in the fire!

It is important that the rank and file personnel in oil exploration understand what is taking place, namely reorganization, consolidation merger, and economic cost-cutting, is a permanent feature of our domestic oil economy, that the "good old days" are gone forever.

O. C. Clifford, Jr.'s October 20, 1958 Oil and Gas Journal paper, "Explorationists: You're on the Spot!", should be reprinted because this presidential address before the Society of Exploration Geophysicists correctly forecast what has since taken place. Clifford aptly named it a "revolution" in very bold terms without beating around the bush.

Maury M. Travis,
Denver.

Good? It was dismal

Dear Sir:

I was astounded to read on page 57 of your August 10 issue the story entitled "Oil Stages Great First Half in 1959." In view of the pessimistic attitude of your magazine toward the statistical and price outlook for the petroleum industry in which I concur, how could oil earnings record spectacular profits as your article indicates?

A comparison of oil company earnings for the first half with earnings of industry generally reveals a rather dismal period for the oil industry. Furthermore, the censensus among oil executives seems to expect the second half to be very much like the first half.

In fact, if second half oil earnings are no better than the first half, they will fall below second half 1958 earnings. This again is a dismal outlook because industry generally will show a very sharp increase in second half 1959 earnings as compared with second half 1958 earnings if we wash out the effect of the steel strike.

I think you will find interesting reading in the August letter of The First National City Bank of New York which tabulates earnings of various industries for the first half of the year.

Surveying 608 companies in many industries, the table shows that earnings for the oil industry were up 25% in the first half of 1959 compared with the first half of 1958. However, other industries showed an increase of 80%. In the most recent quarter which compares with the bottom of the recession in 1958, oil earnings were up 30% and other industry earnings were up 96%.

In view of the fact that the FRB index of industrial production is above 150 as compared with a low of 126 in April 1958, and general industry has shown almost a doubling of earnings, it appears to me that a 30% gain for the oil industry is most disappointing.

I hope you will bring this to the attention of the writer of the article to which I referred. It is impossible to appraise oil industry earnings without looking at the earnings of other industries at the same time.

Edmond N. Morse
Smith, Barney & Co.
New York.

Letters to They Say should be addressed to The Editor, The Oil and Gas Journal, Box 1260, Tulsa, Okla.

CALENDAR OF EVENTS

SEPTEMBER

21-23 Texas Society of Certified Public Accountants, sixth annual institute on taxation, Houston.

21-23 Columbia University, oil refinery workshop on passive element analog computers, Engineering Building, Columbia University, New York.

21-25 Instrument Society of America, annual instrument-automation conference and exhibit, International Amphitheater, Chicago.

22-23 National Association of Corrosion Engineers, Shreveport, La., section, eighth annual corrosion control short course, Centenary College, Shreveport.

23-24 Western Petroleum Refiners Association, Rocky Mountain regional technical-industrial relations meeting, Henning Hotel, Casper, Wyo.

24-25 Mid-Continent Oil and Gas Association, Louisiana-Arkansas division annual meeting, Roosevelt Hotel, New Orleans.

27-29 National Association of Oil Equipment Jobbers, annual convention and trade show, Hotel Leamington, Minneapolis.

27-30 American Institute of Chemical Engineers, national meeting, Hotel St. Paul, St. Paul.

29-30 Western Petroleum Refiners Association, management seminar, Western Hills, Wagoner, Okla.

28-Oct. 1 American Welding Society, fall meeting Sheraton-Cadillac Hotel, Detroit.

29-Oct. 1 National Association of Corrosion Engineers, western region conference, Bakersfield Inn, Bakersfield, Calif.

OCTOBER

1-2 National Association of Corrosion Engineers, southeast region conference, Jacksonville, Fla.

2-3 Association of Desk and Derrick Clubs of North America, eighth annual convention, Hilton Hotel, San Antonio, Tex.

4-7 Society of Petroleum Engineers of AIME, fall meeting, Memorial Auditorium, Dallas, Tex.

5-7 American Gas Association, annual meeting, Conrad Hilton Hotel, Chicago.

5-7 National Association of Corrosion Engineers, northeast region conference, Lord Baltimore Hotel, Baltimore.

5-10 Society of Automotive Engineers, national aeronautic meeting, aircraft engineering forum, and aircraft engineering display, The Ambassador, Los Angeles.

7-8 Western Petroleum Refiners Association, fourth annual stream pollution and waste disposal conference, Broadview Hotel, Wichita.

7-10 Rocky Mountain Association of Geologists, eleventh annual field conference, Saratoga Inn, Saratoga, Wyo.

8-9 California Natural Gasoline Association, annual fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.

8-10 American Association of Petroleum Geologists, Southwestern Federation of Geological Societies, second annual regional meeting, Coliseum, Lubbock, Tex.

8-10 Exploration Drilling symposium, sponsored by University of Minnesota, Colorado School of Mines, and Pennsylvania State University, University Park, Pa.

8-11 Louisiana Gulf Coast Oil Exposition, Lafayette, La.

11-13 American Association of Oilwell Drilling Contractors, annual meeting, Skirvin Hotel, Oklahoma City.

11-16 American Society for Testing Materials, Pacific area national meeting, Sheraton-Palace Hotel, San Francisco.

12-15 National Association of Corrosion Engineers, south central region conference, Cosmopolitan Hotel, Denver.

13-14 Seventh Annual Gas Measurements Institute, National Guard Armory, Liberal, Kans.

16-17 University of Texas, E. P. Schoch lectures series, process control, University of Texas, Austin.

20-22 American Standards Association, national conference on standards, Sheraton-Cadillac Hotel, Detroit.

20-22 National Association of Corrosion Engineers, north central region conference, Cleveland.

20-22 American Society of Mechanical

Engineers, American Society of Lubricating Engineers, lubrication conference, Sheraton - McAlpin Hotel, New York.

22-23 American Institute of Mining, Metallurgical, and Petroleum Engineers, Los Angeles Basin section, fall meeting, Huntington Sheraton Hotel, Pasadena, Calif.

23 Natural Gasoline Association of America, southern regional meeting, Carlton Hotel, Tyler, Tex.

26-27 Independent Petroleum Association of America, annual meeting, Statler-Hilton Hotel, Dallas.

26-27 Independent Natural Gas Association of America, annual meeting, Westward Ho Hotel, Phoenix.

26-28 Society of Automotive Engineers, national transportation meeting, La Salle Hotel, Chicago.

27 American Institute of Chemical Engineers, New York section, technical symposium, Hotel New Yorker, New York.

28-29 Western Petroleum Refiners Association, annual question and answer session on refining technology, Rufus Garrett Hotel, El Dorado, Ark.

28-29 Armour Research Foundation of Illinois Institute of Technology, annual computer applications symposium, Morrison Hotel, Chicago.

28-30 Society of Automotive Engineers, fuels and lubricants meeting, La Salle Hotel, Chicago.

28-30 American Association of Petroleum Geologists, Mid - Continent regional meeting, Broadview Hotel, Wichita.

29-30 Oil Recovery Symposium on Southwest Texas, sponsored by southwest section of AIME and Texas Petroleum Research Committee, Driscoll Hotel, Corpus Christi, Tex.

NOVEMBER

2-4 Geological Society of America, annual meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.

4-6 Rocky Mountain Oil and Gas Association, fourteenth annual convention, Brown Palace Tower, Denver.

4-6 Institute of Radio Engineers, national automatic control conference, Sheraton Hotel, Dallas.

9-10 National Academy of Sciences-National Research Conference, first international symposium on fire research, National Academy of Sciences, Washington.

9-11 American Petroleum Institute, thirty-ninth annual meeting, Conrad Hilton, Palmer House, and Congress hotels, Chicago.

9-12 Society of Exploration Geophysicists, twenty-ninth annual meeting, Biltmore Hotel, Los Angeles.

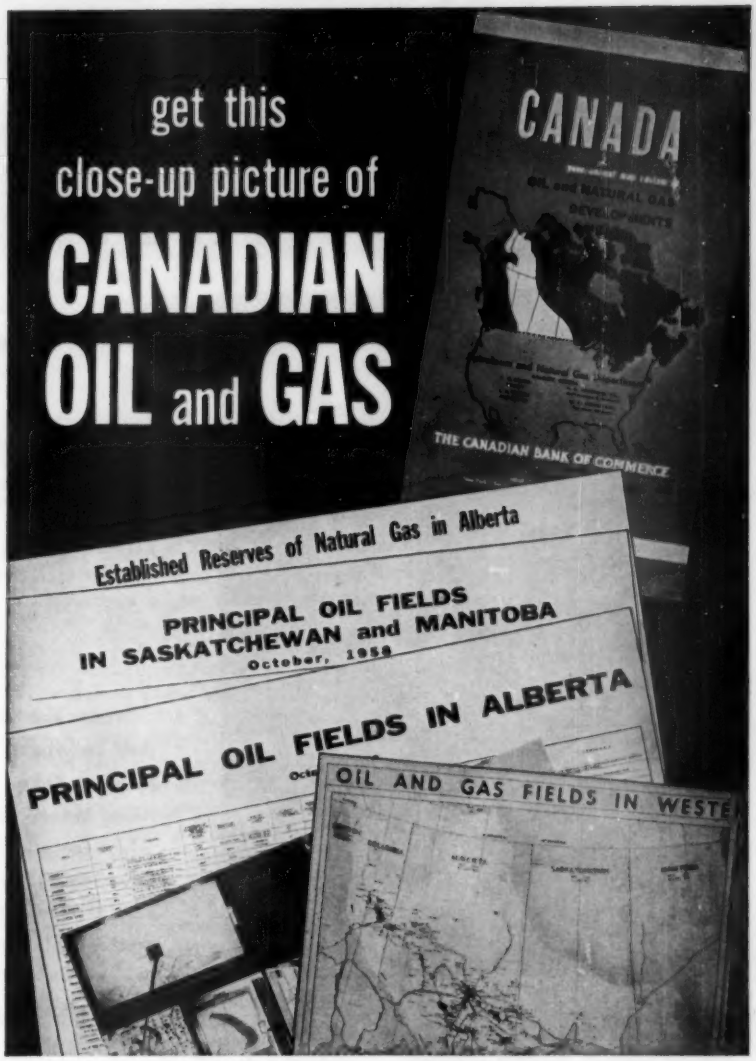
19 West Central Texas Oil and Gas Association, annual meeting, Hotel Windsor, Abilene, Tex.

17-18 Natural Gas Pipe Line Institute, new Seward County Courthouse, Liberal, Kans.

16-20 Fifth International Automation Congress and Exposition, New York Trade Show building, New York.

20 Natural Gasoline Association of America, Panhandle Plains regional meeting, Herring Hotel, Amarillo, Tex.

29-Dec. 4 American Society of Mechanical Engineers, annual meeting, Chalfonte Haddon Hall, Atlantic City, N. J.



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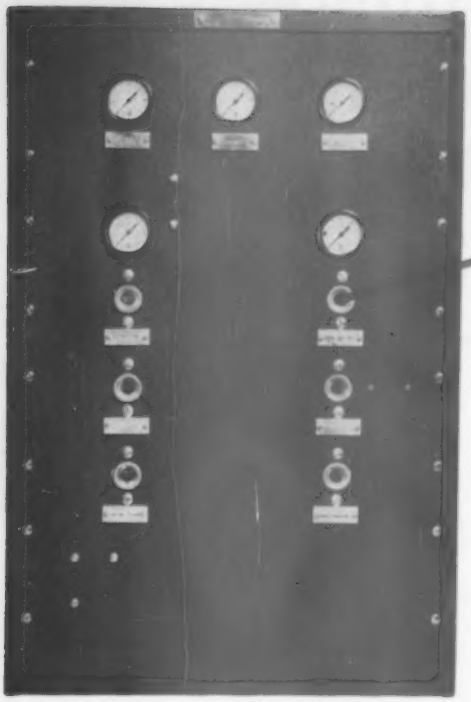
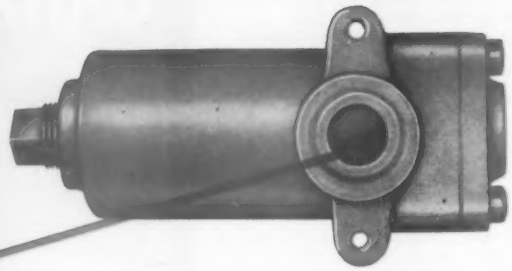
WHAT CAUSED THE ENGINE SHUT-DOWN?





AMOT Pressure Operated
Fuel Shut-Off Valve

Was it low oil pressure, high water temperature, or what? The new Amot Model 2400 indicating Relay used in combination with the Amot Safety Control System tells you exactly which engine hazard caused the shutdown. Saves everyone the time and trouble of a process of elimination. The Indicating Relays are mechanical, actuated by gas pressure or compressed air—no electrical connections involved. When all safety conditions of the engine are satisfied, the indicating window of each relay shows green. If a dangerous condition arises, the covering safety component vents, causing the corresponding relay window to show red—shutting down the engine. All other windows remain green. Can be installed on existing engines with no changes in starting or operating procedure. For information on components, complete systems including control panel and diagrams, write for Bulletin Q-5.3.

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the Journal said...

50 years ago

September 20, 1909

After 4 years on two wells drilled south of the main Salt Lake fields in Los Angeles County, California, Thomas Joyce has found oil at 2,000 ft. The oil contains 85 to 90% asphalt and is similar to but heavier than that at Sunset which has gained wide reputation as a road maker. It won't pump, so air compressors are being set up to lighten it.

Top Gulf Coast field now is Humble, north of Houston, with daily production of 7,500 bbl. Jennings, in Louisiana, is second with 5,100 bbl. daily. Following, in order, are: Sour Lake, Spindletop, Saratoga, Batson, Caddo (North Louisiana), Hoskins Mound, Anse La Butte, Goose Creek, Welsh, Dayton, Piedras Pintas, and Markham.

25 years ago

September 20, 1934

John D. Rockefeller, may not be able to make his customary Florida trip this year. Physicians who had advised him to start earlier than usual have counseled delay.

Royalite Oil Co. plugs and abandons its famous "million-dollar gusher", discovercer 10 years ago of the deep (3,740-ft.) Madison crude-naphtha horizon in Central Turner Valley field, southwest of Calgary. The well, No. 4 LSD 12, flowed more than 500 bbl. of naphtha daily for 5 years only partly under control. Gas and liquids produced were valued at more than $5,000,000.

The spotlight now is on the new Cooper field, in Lea County, southeastern New Mexico, as a coming major producing area. The nine big wells completed to date had initial flow rates totaling 48,730 bbl. daily. Oil Administrator Ickes has set a 12-well limit for the 1934 development program, but already 8 additional wells, all requiring offsets, are drilling.

10 years ago

September 22, 1949

California overproduction reaches alarming proportions, pushing daily oil output above 900,000 bbl. Concern felt over oil situation east of Rockies.

Devaluation last week of British pound threatens international markets with stiffer competition between sterling and dollar oil.

President and other high officials of Cuban Republic join Cuban Gulf Oil Corp. in celebration of spudding of deep wildcat test 3½ miles offshore in Cardenas Bay, on Cuba's north coast.

Doheny oil properties in Fresno County, California, bring $35,000,000 in giant sale to Nassua Associates, Inc., subsidiary of Dillon, Read & Co. Transfer embraces 2,570 acres, and 72 producing wells making 6,000 bbl. daily.

JOURNALLY SPEAKING

Radiocarbon dating—aid to archeology

HUMBLE Oil & Refining Co. is an outfit that takes its civic duties seriously—and in a way you'd never suspect.

At the Humble lab in southwest Houston, geologists and chemists are lending their time, equipment, and know-how to the world of archeology.

Their contribution: radiocarbon dating of archeological samples as much as 40,000 years old.

Radiocarbon dating is a new science, born since World War II, but already it has proved itself a reliable and priceless method for proving the date of objects found in buried cities, tombs, prehistoric campfires, and other locations where ancient man left traces of life.

Its most spectacular use has been to fix the approximate date of the Dead Sea Scrolls which, when first discovered, were suspected of being outright fakes or perhaps only a few hundred years old. Tests of linen wrappings on the scrolls made by Dr. W. F. Libby, the father of radiocarbon dating, proved they were deposited in caves near the Dead Sea at about the time of Christ.

With Humble, of course, radiocarbon dating is primarily an arm for geologists in fixing the age of recent sediments. Humble is one of only three oil companies (Magnolia and Shell are the others) which have developed such systems so far.

But anyone getting into the radiocarbon dating business soon finds the archeologist knocking at the door. Humble obligingly has opened it.

Over the past 5 years, the laboratory has dated at least 100 ancient objects for the cause of archeology and, on one occasion, startled the scientific world with a discovery that some experts still find hard to believe.

This was the dating of a piece of charcoal found by an amateur—but well-recommended — archeologist at Lewisville, Tex., near Dallas. The charcoal came from long-buried hearths of ancient man and tested to an age of more than 37,000 years—thus pushing back earlier estimates of man's arrival in the Western Hemisphere by some 30,000 years.

The Humble lab crew doesn't pretend to know anything about archeology, but it does know its equipment.

The method for setting the date of an object that once lived is far too intricate to describe in this space, but the network of tubes, pipes, flasks, valves, tiny furnaces, Geiger counters, and electronic apparatus produce a final figure that has been proved correct many times by tested standards.

Basically, the method consists of determining the amount of radiocarbon that has decayed in an object that once was alive. When the object dies, it loses half its radiocarbon in 5,600 years, give or take a few. In another 5,600 years it loses half the radiocarbon that's left, and so on.

To find out how much radiocarbon remains in the testing sample, the equipment converts the carbon into carbon dioxide gas, extracts all radioactive materials except radiocarbon, eliminates all impurities, and then "counts" the radiocarbon with a counter under elevated pressure.

By correlating the amount of radiocarbon in the ancient sample with the amount in a modern sample, the researchers can come up with the age figure they're looking for.

Lest any amateur mound diggers who read this think that Humble's expensive and delicate equipment is available to anyone who walks in the front door with a suspected mastodon thigh bone tucked under his arm, we hasten to explain that Humble's time and facilities are limited, and screening is necessary.

Radiocarbon dating is done only for persons affiliated with nonprofit organizations, such as museums and universities. The project must hold some promise of yielding information of archeological value, and, all things being otherwise equal, Humble prefers that the object tested come from Humble's own operating area.

Humble has gone about this public service work without fanfare or publicity. The men in the laboratory ask to remain anonymous. But we thought you'd like to know what one oil company, at its own expense, is doing to advance man's knowledge of his past.

—Howard M. Wilson.

Now SKF has improved the spherical roller bearing it invented!

This new spherical roller bearing offers even higher capacity than SKF's original, self-aligning bearing – and meets the needs of today's faster, more productive machinery. In some cases, the increase in capacity is as much as 54% – corresponding to more than 4 times longer service life!

Here's how these improvements have been obtained:

1. Eliminating undercuts and integral flanges – helps provide space for larger rollers and longer effective contact between rollers and races.

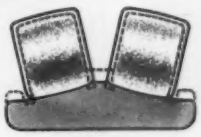

Fig. 1

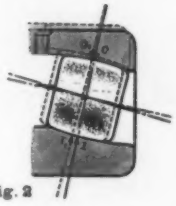

Fig. 2

2. Using symmetrical rollers, unrestricted by flanges – ensures uniform load distribution over the roller length at all times, even under heavy thrust load.

3. Using an axially floating guide ring – provides effective roller guiding, and minimizes friction at roller ends.

Fig. 3

Fig. 4

4. Using a strong "window-type" cage for each row of rollers—helps ensure dependable operation over a full range of loads and speeds.

5. Placing a lubricant duct in the center of the outer ring—helps channel lubricants directly to the rollers and push contaminants away.

Fig. 5

For full details on this new high-capacity spherical roller bearing call the nearest SKF sales office or authorized SKF distributor listed in the yellow pages of the telephone book.

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The year that intrastate gas sales paid off

MAJOR DEVELOPMENT of intrastate markets for natural gas has gone beyond the talking stage; 1959 will go down as the year that producers' search for unregulated markets paid off handsomely. And so now there is fresh reason to ask: What impact will this have on the dizzying postwar climb of interstate sales?

Thus far, the U. S. producer has been like Old Faithful, the famed Yellowstone geyser which never runs out of steam in spite of the passage of time—and recently, an earthquake. He can be counted on each year to meet a demand which seems to have no ceiling. The interstate natural-gas industry has the appearance of a growing giant with an insatiable appetite which is being fed from a horn of plenty.

Since 1946 marketed production of natural gas has increased 180% while interstate sales have increased over 470%. Of the volume gain made by marketed production, more than 75% is attributable to interstate sales. During this period, the interstate market has grown from 28% to almost 60% of the total market.

Whether natural gas is paying its own way in its Siamese-twin partnership with oil is still being debated. But the fact that the producer has always met the challenge of finding ever-increasing supplies is a testimony to his faith in the future, although at times there has seemed little justification for that faith.

FOR THE PRODUCER has had to weather several "earthquakes" himself. Since he was jolted by the 1954 Phillips decision of the Supreme Court which placed his interstate sales under federal control, there has been a mounting drive to make intrastate contracts whose terms are not subject to change by FPC. And that drive has had signal success. (See story page 101.)

If further incentive were needed, the producer has been shaken up again by FPC's conditional approval of Transwestern's Texas-California line. Producers whose prices have been pared 1 to 6 cents an M.c.f. must take a hard, new look at a multimillion-dollar drilling investment whose payout has been altered drastically.

With these recent developments, it again becomes fair to ask: Will the oft-predicted drying up of interstate supplies come to pass and hence bring about the oft-predicted tapering off of long-line construction?

History has taught that a dynamic demand such as the one with which we are dealing seems to attract a supply, if not in this country, then in others. If the producer wants to continue selling gas on a large scale, then he will sell much of it interstate.

But the rest of the natural-gas industry which depends heavily on the producer, and the regulatory bodies whose job includes, among other things, the protection of the consumer's supply, must sometimes wonder what another earthquake might do to Old Faithful.

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The Trend in Gas Sales . . . more are now bucking the tide.
How Gas Sales Have Grown:
Trillion cubic feet
Total Marketed Production
Intrastate Sales
Interstate Sales
'46 '47 '48 '49 '50 '51 '52 '53 '54 '55 '56 '57 '58est.
Interstate Sales Are Still Taking a Growing Share of the Market.
%
% of Marketed Production

Intrastate Gas Sales Gain Momentum

• Pan Am is latest to add its name to the list of companies making a strong bid for gas business within state boundaries. Reason for the trend is simple: It's only good business to avoid the uncertainties of federal regulation.

TALK of intrastate markets has flourished among independent producers of natural gas since their interstate sales were placed under federal control in 1954.

Such statements have somehow had a hollow ring. Until recently there was little evidence to support them. There have been notable examples of intrastate projects, but they were so rare as to emphasize the very scarcity of big sales of this type.

Now the efforts to develop intrastate markets, free of Federal Power Commission regulation, can no longer be dismissed as only verbal gestures. Enough success can be claimed by enough companies to give the movement the stature of a budding trend, although the accompanying charts show no such impact yet.

Who's doing it . . . One of the more successful of the major producers in making large intrastate sales is Pan American Petroleum Corp.

Pan American, the nation's second-largest gas producer, last week reorganized its natural-gas sales department. The purpose: To push harder for intrastate deals.

Pan Am believes it "should take a more active part in marketing natural gas within the several states where the firm has gas production," according to Whitney M. Elias, vice president for production.

The formal announcement was not news to anyone who has followed the company's operations. Earlier this year Pan Am and others sold the huge reserves of Old Ocean field on the Texas Gulf Coast to Texas Electric Service Co., Fort Worth.

The utility will build a 360-mile line to deliver gas to North Texas power plants. Deliveries will start at 100,000,000 cu. ft. daily, building to 150,000,000 cu. ft. daily or more. The initial price of 21.5 cents, near the top on the Gulf Coast, will escalate to 29.5 cents an M.c.f., it is understood.

Pan Am, as major interest owner in Bastian Bay field of South Louisiana, holds one of the great uncommitted gas reserves estimated at 2½ to 3 trillion cubic feet. Several pipelines have made overtures for this prize, including propositions which might be outside FPC jurisdiction. But extreme care is being exercised in disposition of a property with such high stakes.

The Pan American Gas Co. is the instrument which Pan Am uses to transport and sell 190,000,000 cu. ft. daily to industries in the Texas City, Tex., area. Organized in 1941 to supply fuel gas for the affiliated American Oil Co. refinery at Texas City, the gas company expanded operations to include service to several other industrial users.

Other intrastate marketers . . . The most outstanding example of what can be done on a state level is Humble Oil & Refining Co., owner of the nation's largest gas reserves but, significantly, not its largest producer.

A year ago Humble added 200,000,000 to 300,000,000 cu. ft. daily in capacity to its Houston-Port Arthur system which serves coastal industries in that booming area. The company is completing a 238-mile 30-in. pipeline linking Houston with the King Ranch gas plant now under construction.

The plant will process 800,000,000 cu. ft. of gas daily. Part of it will be recycled into the producing formation for pressure maintenance. The remainder will be available for local

industrial customers. None of it will go into interstate commerce.

Monterey Oil Co. last June organized Monterey Pipeline Co. to supply and transport natural gas in intrastate commerce in Louisiana. Existing contracts include markets for some 40,000,000 cu. ft. daily.

Shell Oil Co. plans to take 100,000,000 cu. ft. daily from a Houston area gasoline plant for its own refinery and petrochemical facilities.

Other companies have taken steps, such as buying plant sites on which gas customers could locate, to promote unregulated sales.

And why . . . The motive is not hard to find.

It is no more complex than the need to exercise sound business principles, according to the companies involved.

The producer, when talking of a desire to sell intrastate, has been accused of holding gas off the interstate market in retaliation for having been placed under federal control. His answer is best stated by comparing regulated and unregulated sales.

Consider the Pan Am Old Ocean sale. The producer has been assured of what he considers to be a fair price for his gas. It is firm. Neither the price, the production rate, nor any other condition of the contract will be changed by a regulatory body.

He can plan definitely according to set time schedules. There will be no delay of months or years while prosecuting a case through FPC and perhaps the courts. The deal as made will stand for the life of the contract. When the contract expires, that will be the end of the deal.

None of these statements can be made of an interstate sale.

Contrast the conditions surrounding a free-enterprise sale with what FPC has done in the Transwestern case. In granting conditional approval to the Texas-California line, FPC cut wellhead prices by 1 to 6 cents per M.c.f. The pipeline was permitted to take 75% of the minimum without penalty. Producers were required to waive their rights to increase rates subject to refund.

As producers stated in a petition to reconsider, they would never have signed a contract containing provisions which FPC proposed to impose.

Given the option of the two types of sales, there is no question as to which a good gas manager would choose. And he would have no thought beyond responsibility to his company and stockholders.

What next? Of course, the producer does not always have that option.

It is rare when he does. Nor can the Transwestern case be considered typical.

It is not impossible to do business with FPC; the long-line construction pace of nearly a billion dollars annually is proof of that. If it were impossible, the curves on the accompanying charts would be going in the opposite direction.

Intrastate sales, substantial though they have become, cannot at this time be considered a threat to continued rapid expansion of the interstate market. The industry has met and solved bigger problems before. Transmission companies have confidence that sufficient supplies will be available from the U. S., Canada, and Mexico to meet growing interstate demand in the foreseeable future.

But the domestic producer can be expected to grasp every opportunity to make an unregulated sale, at least until procedures which are now being hammered out before FPC and the courts become orderly. And his tendency is more and more to create those opportunities.

What has been achieved thus far by intrastate-minded operators is enough to cause transmission and distribution executives to take notice.

On the other hand, it encourages the producer who wants to keep selling gas but who shies away from dealing with a regulatory apparatus which is still unpredictable and changing.

Soft Markets

A HARD-TALKING Texas independent, Jake L. Hamon of Dallas, hurled a challenge last week to "the 30 large companies" to bring their stock levels into line and "avert disaster" for the oil industry.

Hamon did not name "the 30 large companies" in his address before the Texas Mid-Continent Oil & Gas Association in Houston—but there was little doubt he was placing the burden for cutting inventories on the nation's big refiners.

Using strong language to describe the plight of the industry, Hamon at one point said oil men are acting "like a bunch of blithering idiots."

At the outset, he told the Texas audience: "I am going to try to get over some kind of a message on the present sad state of our industry, which is caused solely by dumbness. I am going to talk on our inventory mismanagement, because I believe that it is so serious that it is liquidating the domestic producer and the domestic producing industry."

The industry's failure to obey the laws of supply and demand, he said, has hurt it in the stock market, where other stocks go up but oil stocks stand still or decline.

"Apparently they recognize our lack of brains in the conduct of our affairs," Hamon commented.

watching WASHINGTON

Clyde La Motte

Oil prices: a key to controls . . .

THE FUTURE of oil import controls rests to a large extent on prices.

If prices stay in their present "soft" state, there is little likelihood of any major changes in the program.

But if prices go up—no matter what the justification—import controls will be blamed. This will set the stage for efforts to ease controls or to apply price ceilings.

You will recall that President Eisenhower, in approving mandatory controls, warned that a close watch would be kept on prices. That warning still stands, especially with an election year just ahead. Administration officials, particularly those not directly involved in the controls program, remain jittery, fearing a political issue.

Even the Oil Imports Administration is cautious. That was behind the OIA's recent move to publish monthly reports on company-by-company residual-fuel imports. OIA wants to be sure that any rise is resid prices comes only after the companies are importing all they can.

Strangely enough, some of the quickest squawks over

Due to Poor Management, Hamon Says

Main attack . . . Next Hamon turned to the refiners and marketers for the main brunt of his attack.

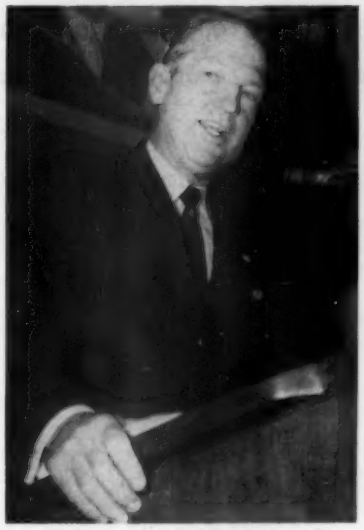
"I ask you, should we as a group, or should the domestic producing industry as a whole pass out of existence due to the inability of the refiners and marketers to properly manage their inventory problems? Yet, that is happening now. I'm not pessimistic. I'm factual, calm, and deadly serious about this problem," he said.

Hamon took refiners to task with these statistics: Gasoline use has risen 58% in this decade, but gasoline stocks are up 125%. Distillate demand rose 87%, but stocks rose 103%.

The industry, as a result of carrying too much stock on hand, lives in a "constant state of crisis."

"In gasoline stocks our record has been simply terrible and verges on the unbelievable," he said. "We started out 10 years ago with too much gasoline on hand, and we have continued to put more and more of it in storage until now, at the end of our high consuming season, we have 183 million barrels on hand."

Refiners cause the excessive stocks, he charged, because they want to cut unit costs, and to do so they produce at capacity. And capacity, for both producing and refining, is far in excess of demand.



Jake L. Hamon
. . . oil men are acting like "blithering idiots."

The rate of current refinery runs is about 400,000 bbl. daily too high—"and it won't be corrected, I suppose, until refined prices drop to pieces, and management directs the refining department to reduce runs, or perhaps the price of crude will take another downward swing."

Management problem . . . Hamon then laid the responsibility "in the hands of the management of about 30 companies."

"I am addressing these remarks to the head men who direct the policies of the 30 large companies. This is your individual responsibility. It cannot be regarded as an industry responsibility. It is the job of top level management in each company . . .

"The president of each large unit must look at industry totals, then look at his own picture and determine the stock level that is ample for his own company and stick firmly by such a program. If every company president would make it his job to see that his own outfit keeps its stocks in good shape, there would be no reason for us to be in the dilemma we now find ourselves."

Hamon said he "cannot believe that the top management in a great industry like ours will let us go down the drain."

"We have made a magnificent record of achievement in every emergency that has confronted us," he said. "I hope that our present emergency will be heeded. It can and must be solved by a determined effort on the part of top individual management in each company."

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price changes come from within the industry. When a gasoline price hike was announced in California recently, a company wrote OIA, blaming District 5 import quotas. Yet, says OIA, that same company blamed controls when a cut was made in California crude prices.

The showdown will come when and if economic factors force oil prices up. Although the industry may get support from administration officials familiar with the facts, this will not deter oil critics from raising a hue and cry. Don't underestimate this danger.

Setting the stage for next year . . .

ALTHOUGH CONGRESS has gone home, oil may be affected by two hearings this fall.

The big one is the start of a major tax study by the House ways and means committee. This may set the stage for numerous tax changes, although it is unlikely that any complete overhaul of the nation's tax will result.

Oil's big stake is the depletion provision. Congressional critics of oil will probably launch an all-out attack on this provision next year. Thus, the findings of the committee will have an important bearing.

The hearings, originally scheduled to open November 2, have been delayed until November 16 because Congress remained in session so long.

The other investigation concerns oil leases. Specifically, Sen. Clinton Anderson (D.-N. M.) wants to look into reports that some leases of government lands obtained at minimum prices on a noncompetitive basis were promptly resold at a huge profit.

Even if no chicanery is involved, Anderson figures the Government could be getting short-changed. The probe could cause a renewal of efforts to have all such leasing put on a competitive bid basis.

And Anderson's hearings may not end there. The grant given him by the full committee includes authority to investigate "any matters pertaining to the development of mineral resources of the public domain." That gives him a large field in which to roam.

His New Mexico hearings have been delayed. No new date has been set, but early October is a good bet.

Readying for an oil emergency . . .

AN OIL MAN'S Washington checklist should include these events and developments:

. . . Oil executive reserves. You may be tabbed for this. Interior's Office of Oil and Gas is moving forward with its program to line up top oil officials to serve on regional staffs in a national emergency.

. . . NATO. Imports Administrator Matthew Carson will be in Paris October 8 for a meeting of the NATO oil planning committee. This involves long-range planning to meet oil emergencies through international cooperation.

. . . TEL safety. Lead content of gasoline could be raised to 4 cc. a gallon without any significant increase in the hazard to public health, or without increasing the danger in manufacture or distribution. So reports a special committee appointed by the Public Health Service. It does advise, however, that any increase from the present maximum of 3 cc. per gallon be done gradually.

What Oil Can Expect in Next Session

• The outlook: No drastic oil issue is on tap when Congress reconvenes in January, but there will be several proposals affecting the industry.

JUDGING by what Congress did—and didn't do—this year, the oil and gas industry doesn't have a great deal to fear when that same Congress reconvenes in January to tackle the big backlog of unfinished business.

Congress did pass a major labor reform bill, but that legislation is not expected to have any really major impact on existing oil union practice and relations between labor and oil management.

And Congress passed a piece of legislation affecting oil leases: It protects leaseholders who innocently acquired leases originally obtained by others in violation of acreage limitations. (It also approved an increase in Alaskan lease acreage limitations, but that got vetoed.)

Meanwhile, the Eighty-sixth Congress saddled gasoline and diesel oil consumers with an additional tax of 1 cent a gallon to help make up the deficit in the Highway Trust Fund. It did give independent jobbers this break: They will be permitted to pay the tax when they sell their gasoline, rather than when they buy it.

All in all, there wasn't a really vital oil issue settled by Congress this year. And none is in prospect for next year unless a sudden shift in circumstances puts the spotlight on the industry.

Even so, Congress will deal with a wide variety of legislation it left unfinished when it went home last week. Some of these proposals affect oil directly or indirectly.

This is the outlook now:

... **Depletion.** A sharp attack will be made on percentage depletion, but the mood of Congress at adjournment indicates that the attack is likely to fizzle. This won't mean the end of the fight, naturally, but the real showdown probably will be postponed until an over-all tax study has been completed—perhaps in 1961.

... **Leasing laws.** New impetus will be given to several proposed leasing law changes which fell by the wayside during the session which just ended. These include: Establishment of a single acreage limitation for both federal leases and options; an extension of the base period of federal leases from 5 years to 10 years; and an increase in the minimum rental on public lands to 50 cents an acre per year.

Sen. Ernest Gruening (D.-Alaska) will also try again to obtain an increase in the acreage limitations in Alaska, but he's likely to bump into the same administration opposition which resulted in a presidential veto of the measure this year.

... **Import controls.** There is an outside chance that a push will be made to get congressional action to control the oil imports program. Such a bill was introduced this year but gathered dust after the administration imposed mandatory controls.

The bill isn't likely to make much headway next year either, unless a major snarl develops in the administration's handling of the problem. However, some congressmen still feel that Congress, and not the executive branch, should establish the ground rules.

... **Tanker restrictions.** Some independent tanker operators and seamen unions will put fresh steam behind a drive for legislation which would specify at least 50% of oil imports into the U. S. be shipped in U. S. flag tankers. Any substantial idling of tankers or seamen during the next few months could add impetus.

... **Marketing.** Several proposals affecting marketing, including a restriction of "good faith" price cuts, advance notification of price increases, and a national "fair trade" law re-

Conoco Enlarges Plans for Political Action

. . . as it appoints a Washington lobbyist, assigns him an assistant, and urges employes to enter practical politics.

CONTINENTAL Oil Co.'s foray into the world of practical politics was described in detail for the first time last week by Harry J. Kennedy, senior vice president, in a speech to the Salt Lake City Chamber of Commerce and Rotary Club.

Kennedy said Continental's purpose is not to "create some kind of countervailing or antiunion center of power or political force" but instead seeks to "preserve a favorable economic climate in which business enterprise may continue to earn reasonable profits . . ."

The program has purposes:

... **Protect** the interest of the company, its stockholders, its employes, and its customers.

... **Encourage** employes to become more concerned with public affairs.

... **Encourage** government service by employes, both elective and appointive.

... **Place** management men in a leadership role on important controversial issues.

The first has top billing, and already Continental has named a director of public affairs, Harold Skinner, and an associate, Basil R. Littin, to specialize in government relations in Washington.

The public-affairs specialist, Kennedy said, is registered as a lobbyist in Washington and will present the company's point of view to members of Congress.

The plan to encourage employes to enter politics already is taking shape. Two-day "pilot" workshops are being held in Continental district offices, and "precinct politics" is the heart of the sessions.

Some 30 or 40 employes, representing a cross-section of the company, participate in the workshops. The program is bipartisan—"both political parties need and want their participation."

Citizen comes first . . . Kennedy said the company expects occasional conflict between the employe, as a private citizen, and the company on particular issues.

"In such a situation, it is axiomatic that the position of the individual must take precedence over what he would call 'the company position'," Kennedy said. "We believe this will

ceived scant attention this year and aren't likely to get much more attention in 1960.

...**Mergers.** A bill to require a 60-day advance notice on mergers was bottled up in a committee. However, a continued flurry of mergers may cause its proponents to try again next year.

...**Overseas incentives.** Tax-saving proposals to stimulate U. S. business and industry to increase investments overseas ran into opposition. This, coupled with the Treasury's dire need for revenue, probably dooms such proposals for 1960.

...**Fuels policy.** The coal and coal-related industries will press hard for adoption of resolutions establishing a joint congressional committee to draft a national fuels policy.

The coal people came close to succeeding this year. The Senate passed such a resolution and a companion measure was moving smoothly through the House until Rep. Homer Thornberry (D.-Tex.) and Rep. Hale Boggs (D.-La.) succeeded in getting it held in the House rules committee.

The goal of the coal industry is the establishment of a national fuels policy which would impose end-use controls on oil and natural gas, thereby increasing coal's share of the fuels market.

Some coal people in Washington chuckled quietly at the lack of opposition to its proposals from the oil and gas industry. Said one: "Maybe because they got roughed up a few times in the past, the oil boys are reluctant to show up on Capitol Hill."

Tidewater Seeking Go-Ahead

. . . on secondary-recovery operations in Ventura Avenue field leases. Target is extra 200,000,000 bbl. of oil.

TIDEWATER Oil Co. has started proceedings aimed at secondary-recovery operations on four leases in Ventura Avenue field—one of California's top oil fields.

Water flooding and gas injection would be used to increase ultimate recovery by 70%, or an extra 200 million barrels of crude.

The company is negotiating with royalty owners for permission to start a pilot flood. The four properties involved are those of Ventura Land & Water Co., and the Hartman, McGonigle, and Lloyd leases.

Representing one of Tidewater's largest operations, the four leases lie in the eastern portion of the field. They cover about 1,000 productive acres and contain 334 wells producing more than 15,000 bbl. daily.

The wells produce from the C and D blocks and range in depths from about 4,000 ft. to more than 12,000 ft. Separated by the Barnard thrust fault, each of the two blocks are more than 4,000 ft. thick. The two blocks have 22 producing zones.

The C block has about 124 wells, producing from 16 reservoirs in the interval 4,000 to 7,000 ft. Consultants estimate the ultimate primary recovery of these wells at about 162,000,000 bbl., of which 25,000,000 remains to be produced. Water flooding is expected to increase ultimate recovery to 271,000,000 bbl., an increase of 109,000,000 bbl.

The D fault block, which is below the Barnard fault, has six separate oil pools. Of the wells producing from this block, about 100 are in deep D-7 and D-8 sands and 86 are in the D-5 and D-6. Combined output of these wells is about 10,000 bbl. daily.

Tidewater's preliminary engineering studies indicate substantial additional oil would be produced by a gas injection program in the D sands. Though there is some evidence of a weak water drive in some zones, the field is essentially a depletion-type reservoir. Initial pressures exceeded the hydrostatic pressure in all zones, and by a more substantial amount in the deeper zones.

Tidewater wells in the D zone are estimated to have an ultimate primary recovery of 132,000,000 bbl. Of this, 31,000,000 bbl. has not been produced. Pressure maintenance with gas is expected to increase this recovery by 100,000,000 bbl., or to an ultimate total of 232,000,000 bbl.

Standard Forms Catching On

. . . as five states adopt work-saving system. Government agencies and other states now considering the proposal.

AN INDUSTRY program to standardize report forms on drilling and production for state and federal agencies is bearing fruit.

Since starting its effort in the spring of 1958 to gain approval of the money-saving, time-saving forms (OGJ, Mar. 10, 1958, p. 84), a committee of the Interstate Oil Compact Commission has succeeded in getting them adopted in five states.

Currently the committee is working on several other states and also has received encouragement from U. S. Government officials.

O. P. (Pete) Nicola, chairman of the industry subcommittee of the compact's committee on regulatory practices, made a progress report on the campaign last week to the Texas Mid-Continent Oil and Gas Association meeting in Houston.

Nicola asked the association's committee on forms to urge the Texas Railroad Commission to go along with the program. The committee named a subcommittee for the purpose.

So far, Arkansas, Mississippi, Alabama, Arizona, and Alaska have adopted the forms, and Nicola expects Oklahoma to accept them shortly.

The purpose of the program is to cut down paper work by providing identical forms for each state. The forms also are designed for electrical machine use.

Nicola said several states with large areas of federal land are withholding approval until the U. S. Geological Survey puts its O.K. on them.

Nicola's committee began work on the standardized forms 3 years ago. The committee has developed 33 standard forms, including several alternates. Nicola is director of proration for Phillips Petroleum Co.

be the exception . . . but we are firmly convinced that this principle must be well established in the minds of our employes if any program of employe information is to have any chance to succeed."

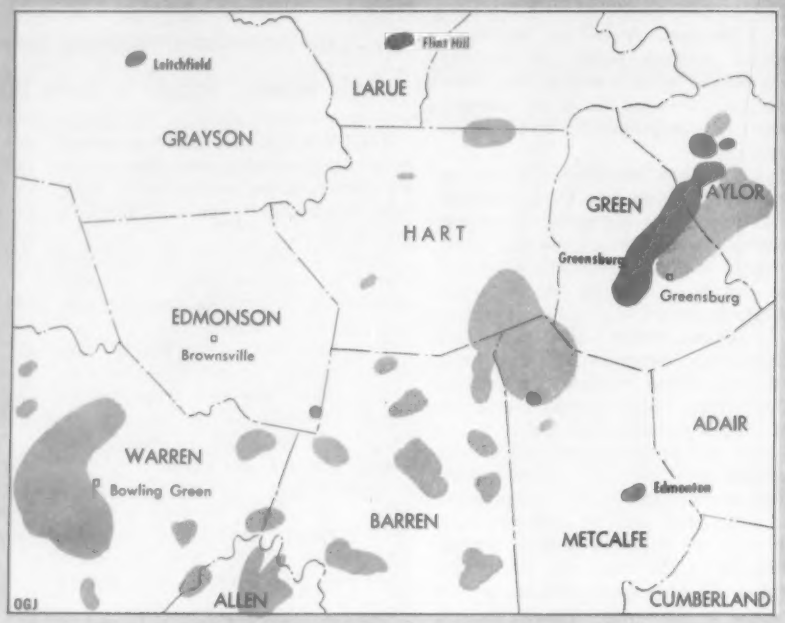
On the question of employe participation in government service—both appointive and elective—Kennedy said the company has not announced a written policy as yet but has encouraged such participation. One production employe in Wyoming is a state legislator.

Continental's purpose in entering the political field actively, Kennedy said, stems partly from the succession of federal laws "establishing a framework of limitations and ground rules with which business must conform."

"During this time, government and politics have been getting more and more into business, and businessmen at the same time have been getting more and more out of politics."

How Central Kentucky's Oil Play Has Grown

Green County is the biggest name in central Kentucky's oil play, but the pace has slowed there and drilling has spread to other spots in the area. Greatest activity now is in Metcalfe and Cumberland counties to the south of Green County. The lease play has extended throughout the central part of the state and into Indiana to the north and Tennessee to the south.



Green County Oil Fever Fans Out

• Peak has been passed in Greensburg activity, but plenty of work still remains. Meanwhile, oil explorers are spreading out in nearly all directions in their search for shallow pools.

George H. Weber
Editor

GREEN COUNTY, Kentucky, is settling down to a prosperous, work-a-day oil field.

Production has declined from its peak of 51,000 bbl. daily in May, and drilling has dropped sharply from the frantic pace set last spring.

But the oil play is far from over.

Exploratory drilling has gained momentum throughout central Kentucky, Indiana, and Tennessee as a result of the successes in the Greensburg field.

The entire Greensburg operation, however, is taking on a new, more settled look, as evidenced by such events as these:

... **Several independent** oil companies have entered the play, contributing a greater degree of stability.

... **New discoveries** have extended the oil interest up and down the western flanks of the Cincinnati arch.

... **Leasing is widespread,** touching the area from central Indiana to the south into central Tennessee.

... **Several major companies** are taking acreage, although none has yet started drilling.

... **Many inside locations** remain to be drilled in proven Green County leases.

Long play . . . Two factors boost the odds for a long and sustained central Kentucky play:

... **Costs are very low.**

... **State controls** are absent for either drilling or production.

Production is reached at an average depth of 500 ft. Using light, cable-tool rigs, operators can drill to the Silurian pay for about $2,500. A well can be completed with modern equipment for $5,000.

Coupled with unrestricted production, these costs make for rapid payout on a strike, provided that lease costs are not out of line. The boom did inflate some lease costs out of all proportion to expected returns. Values which began at $1 per farm before the boom have risen as high as $2,000 per acre for some productive areas. A number of large deals have been closed in and around Green County for six figures, and some exceeded $1 million. At some of these prices, the promise of payout is considered poor.

The promoters who played a large role in these inflated values have come and gone from Green County. They are still very active elsewhere in the state, however; and the stories are rife of unwary investors paying hundreds of dollars for very small interests in single leases or wells.

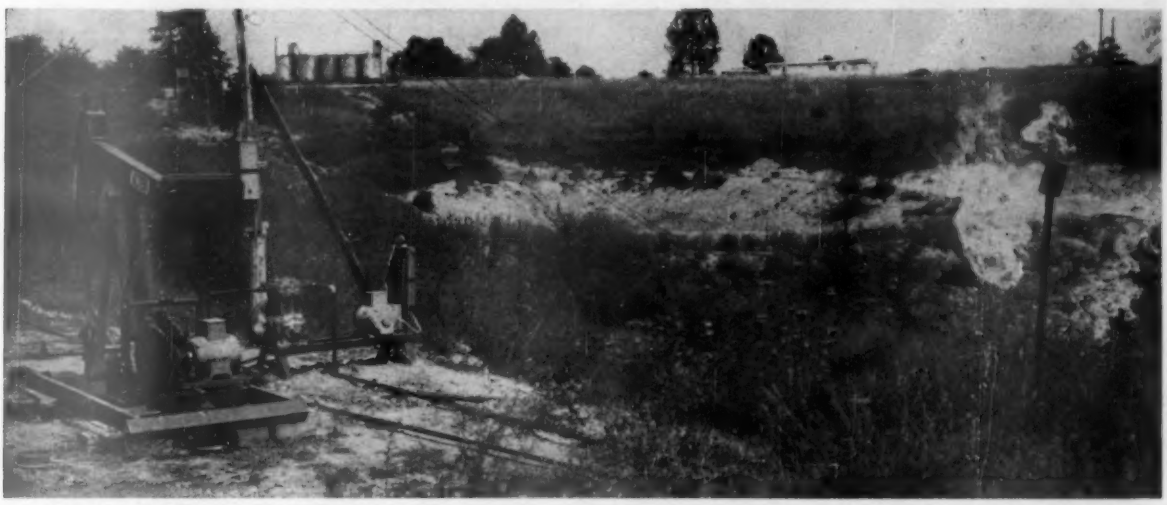
Central Kentucky is still an area where the buyer must beware, but there still remains the promise of profits below ground for those who invest knowingly.

The leasing play is not restricted to independents and local operators. Large blocks in the area are held by Ashland, Gulf, Sun, Carter, Pure, and Hunt. None of them has shown much interest in drilling, however. They are showing interest in making farm-out arrangements.

Drilling trends . . . It is impossible for anyone, even those in the thick

BOOM in central Kentucky was started by the H. L. Lambert 4 Hattie Meadows, which came in for a big well southwest of the town of Greensburg. Other tests had shown small amount of oil, but No. 4 was the well that really kicked off the play.

ONLY FLOWING well in the play was completed in Metcalfe County by Phillip Linder. He used an oil saver and completed the well with the tools in the hole. Note the cut off cable.



PRODUCTION from many wells is boosted by use of vacuum pumps powered by a separate electric motor. Evaporation pits (in background) are no longer used. Salt water is returned to the "Blue sand," usually through the smallest producer on the lease.

of activity, more than to guess the number of rigs operating along the trend.

Drilling permits are not required. In the wooded rolling country, drillers even do not necessarily keep to the sparsely traveled roads. The saying is that locations are spotted by driving a truck-mounted rig across country until it gets stuck.

Organized scouting to check the area is unknown. The best current estimate is that 20 rigs are running in Green County and 17 operating in or near the Taylor County extension of the Greensburg field. This is a considerable drop from the 200-odd water-well and other cable-tool operations active in that area late last spring.

Although the hectic drilling program is past in Greensburg, there still remain hundreds of inside locations to be drilled. This activity is expected to continue for many months at a more leisurely pace.

North and south . . . Greensburg is not yet defined on the north.

Stepouts in Taylor County have found good production; and the field, now roughly 16½-miles long, shows promise of further extension. Again, the pace will be more moderate.

Activity today is highest in Metcalfe and Cumberland counties immediately south of Green. In Metcalfe, a recent strike which may be a freak is still the outstanding success of the entire play. On August 14, Phillip W. Linder of Louisville brought in the 4 Mitchell as the area's first and only flowing well on the south flank of the old LeGrande pool. It made 32 bbl. an hour initially from the Mississippi lime, the Warsaw, or Fort Payne at 515-525 ft. At the latest reports it still was flowing nearly 500 bbl. daily.

This lease had prior production from pumping wells completed in

MOST DRILLING is done with truck-mounted cable rigs since the wells are completed at about 500 ft. Rigs have been brought in from Illinois, Indiana, the Carolinas, and other southern states to join in the boom.

ASHLAND Oil & Transportation Co. buys about 95% of the oil produced in central Kentucky. This pipeline terminal north of Greensburg represents part of the $2 million the company has spent expanding facilities in the area.

SEVERAL supply houses are located in and around Greensburg. One independent has pulled out, but the remainder plan to stay.

June. Offsets to the flowing well are pumping about 25 bbl. daily from the Laurel dolomite of Silurian age, and there is one dry hole offsetting the well on an adjacent lease.

The Edmonton field, 12 miles southeast, has been producing for 3 months. It hit a peak of 3,000 bbl. daily but now has declined to about 1,000 bbl., giving Metcalfe County an average production of about 1,600 bbl. daily from the two fields.

These two successes have attracted 50 rigs to the county. Some wells are projected as deep as 1,500 ft.

Further south in Cumberland County bordering Tennessee, 45 rigs are operating. They have yet to turn up anything promising. Three scattered producers from the Knox formation of Ordivician age are on production. An old hole 5 miles to the north has been drilled into production.

Other directions . . . The Flint Hill field of Hardin County is making about 150 bbl. daily, and other scattered production is coming from Hart County, due west of Greensburg.

Small production also is reported from the Leitchfield area of Grayson County. Twelve rigs are active in Hardin County, and 15 have been spotted in Hart.

Edmonson County recently attracted some interest with an apparent field discovery near Rocky Hill. One well is making 20 bbl. daily from the Coniferous lime of Devonian age 3 weeks after completion. Two offsets to the 461-ft. pay have proven dry.

The latest shows of oil and gas have come from Meade County, bordering the Ohio River southwest of Louisville. A show of oil and gas was encountered in an old hole reopened near Ekron. A new well drilled near Brandenburg Station blew in making a reported 1,500 M.c.f. of gas and about 20 bbl. of oil.

Producing methods . . . Customary field practices are ignored right and left in Green County.

A good example is well spacing. Many leases in the early play were rimmed with wells. Spacing followed no pattern whatever. Wells for the most part were closely concentrated along lease lines.

Some operators believe that close spacing and heavy withdrawals of water will improve the recovery of oil. The facts seem to bear them out.

A peculiarity of the region is this: Water-oil ratios are high in new wells but decline as the wells are produced. Operators refer to "pumping the water off" before they settle down to recovering the oil trapped in the vugular dolomite.

Acidizing has proven the key to production. Practically all new wells are now treated whether or not they

show oil. Some of the early producers in the south end of the field which pumped 100% water for weeks came in with good oil production immediately after acidizing.

The average acid treatment has risen gradually in Greensburg to about 3,500 gal. Some wells are treated with as much as 10,000 gal. The absence of good well records and the dearth of subsurface knowledge generally make acidizing much less the exact operation it normally is.

Service companies chafe at having to operate under such conditions, but business is good. Six firms have been active in the area and operate from 30 to 40 units. One independent is rumored pulling out, but the major companies expect to remain for a long period.

Halliburton has moved into new modern quarters leased on the south edge of Greensburg. Dowell has nearly completed a new headquarters and warehouse in the same area.

Fracturing was tried in some central Kentucky wells with little success. Some fracturing is practiced in Knox formation wells with some promise.

A number of wells in the Greensburg pool now are being reacidized with mixed results. Older wells originally given smaller treatments show most success.

Mothballs and rock salt are used in many cases to prevent the acid from channelling. Some experimental work with magnesium pellets is showing promise. The pellets are placed in the well then followed with acid. The resulting reaction raises temperatures and is believed to give greater acid penetration.

Central Kentucky Production

	Barrels	
	Average daily	Monthly total
1958		
May	424	13,144
June	457	13,170
July	571	17,701
August	945	29,388
September	3,317	99,510
October	8,168	253,208
November	13,583	407,490
December	15,587	483,197
1959		
January	17,000	527,000
February	19,540	547,120
March	23,815	738,265
April	36,348	1,090,440
May	*43,632	1,352,592
June	41,474	1,244,220
July	33,249	1,030,719
August	31,000	930,000

*Peak day was nearly 51,000 bbl.

Prosperity . . . The townspeople and farmers in Green County are still reaping most of the benefits from the oil play.

In most instances they retain substantial interest when they sell leases at handsome profits.

As a result there are several new millionaires in and around Greensburg. Scores of landowners also have realized many times the original value of their farms.

But there is little evidence of this new wealth. In keeping with their conservative background, the citizens of Green County have foregone the usual signs of sudden riches. An often-heard remark is that most of the Cadillacs around town have Texas licenses.

Greensburg itself is still bustling with hard hats. While the play has slowed, the town expects to continue as a focal point for services supply, and crude movement.

On the busy town square, the visitor can still park for a nickel an hour. If he plans to overpark, he simply lines up the nickels on his dash, and the police obligingly keep the meter running.

Oil fever has spread throughout central Kentucky from the Ohio River to Tennessee. But there is a subdued tone to it. Throughout the area the people recognize that this boom may prove only a temporary fourth "B" to the three "B" way of life they have followed for generations.

To them this new prosperity means capital to invest in their existing economy based on burley, bourbon, and blue grass.

PROCESSING BRIEFS . . .

A new catalytic hydrodealkylation process, tradenamed Hydeal, is available for licensing by Universal Oil Products Co. It resulted from research by Ashland Oil & Refining and UOP. Initially, it can be used for production of benzene from feed stocks such as toluene, xylenes, and heavier aromatic mixtures. The process also may be applied for making phenol and naphthalene from higher-boiling, substituted phenols and alkylanaphthalenes.

A new polypropylene plant will be built by Dow Chemical at Torrance, Calif., adjacent to Dow plants which produce polystyrene, rigid plastic foam, and other products. The plant will be the first of its kind in western U. S. It will be completed in 1961.

Frontier Refining Co., Denver, is completing a deal to buy Western States Refining Co., Salt Lake City, for $5.6 million. Western States' directors have accepted Frontier's offer to buy all outstanding stock for $3.50 a share. The proposal will be presented to stockholders soon. Western States operates two refineries, a 7,500-bbl. plant at Salt Lake City, and a 2,500-bbl. plant at Farmington, N. M. The company also owns 165 "Beeline" service stations in the Rocky Mountain area. The deal would boost Frontier's refining capacity of 30,000 bbl. and retail outlets to 965.

Standard Oil Co. (Ind.) is acquiring True's Oil Co., Spokane, in a stock-exchange deal. The 60-year-old marketing company has about 125 retail outlets and 22 bulk plants in eastern Washington, northeastern Oregon, and the panhandle area of Idaho. Utah Oil Refining Co., an Indiana Standard affiliate, will manage True's operations.

A new four-tower fractionation unit has been placed in operation at Ashland Oil & Refining's Catlettsburg, Ky., refinery. Current production primarily is in commercial and specialty solvents although the plant is designed to manufacture special fuels for missile and jet engine development. A total of 10,000 bbl. daily in finished products can be processed. Procon, Inc., Des Plaines, Ill., was builder.

Also for Refiners . . .

IN THE NEWS: Soft product markets due to poor management of crude inventories, Jake Hamon tells Texas Mid-Continent Oil and Gas Association (p. 102) . . . Fuel cell is still 5 years away from commercial use (p. 110) . . . New study gives the reasons why so many service stations fail (p. 114) . . . Plans for constructing new refineries in four countries are in the mill (p. 122).

PLUS THIS TECHNICAL REPORT: Sohio's dual gas-recovery system (p. 223).

Fuel Cell 5 Years Off

. . . according to speakers at ACS meeting. But hydrogen —not hydrocarbon fuels—appears to be the likely fuel.

THE FUEL CELL is making rapid strides toward industrial application and should be ready for commercial use within 5 years.

Unfortunately, conventional fuels will not play an important role in their inception unless formidable stumbling blocks can be overcome.

Hydrogen currently stands out as the ideal fuel. However, development work under way in England may result in a breakthrough for the carbonaceous fuels, members attending the American Chemical Society's 136th national meeting at Atlantic City were told.

The fuel cell will eventually become a major power source replacing other systems in some applications, K. Kordesch, National Carbon Co., Division of Union Carbide Corp., said. Initially it probably will be restricted to uses where excellence of fuel efficiency, silence, freedom from fumes, and simplicity of design and operation are important requirements.

National Carbon's first prototype was used about 2 years ago to power a 28-volt radar unit. This hydrogen-oxygen cell is now being production engineered for practical uses. This particular cell is characterized by use of inexpensive carbon electrodes. Hydrogen fuel is combined with oxygen from air to produce electricity. Water is the reaction product.

As a rule-of-thumb, 1 kw.-hr. of electricity—about the capacity of a 50-lb. car battery—can be produced from ⅛ lb. of hydrogen. Hydrogen is an ideal fuel and can be stored for months in liquid state with a container weight approximately equal to that of hydrogen. For every day purposes, hydrides, decomposed by water, are more convenient choices.

A practical, widely-used fuel cell must operate on air, be inexpensive, and should use a readily available fuel, said Kordesch. Use of carbonaceous fuels (liquids or gases) at low temperatures is one goal National Carbon is trying to reach, he said.

Partial solution . . . Successful hydrogen-oxygen cells represent only a partial solution, agreed H. H. Chambers, Sondes Place Research Institute, England, in a paper prepared jointly with A. D. S. Tantram.

Complete solutions depend on development of cells and batteries to operate at long periods at high efficiencies on more orthodox fuels, such as manufactured gas, natural gas, and vaporized liquid hydrocarbons. Experimental work done at Sondes Place indicates a solution is within striking distance.

Simply-designed cells capable of being stacked to build compact batteries have been built in the laboratory. They use inert porous diffusion electrodes with molten carbonate electrolytes. The Sondes cell is effectively a combined oxygen and carbon dioxide concentration cell in which the primary anodic and cathodic processes are identical.

Work has now reached the development stage and engineering design factors are being studied, he said. The main problems are associated with the choice of materials for the construction of cell bodies. These are rather well defined, however, and no more difficult than those solved in other fields, such as gas-turbine technology.

An attractive development from the standpoint of the petroleum industry has been the use of anodes containing oxidation catalyst in their composition. With a good oxidation catalyst being used, the chemical nature of the fuel is of only secondary importance in determining cell performance.

Experiments show that with a given electrode system, the cell performance runs roughly parallel with ease of oxidation of the fuel. For example, performances with hydrogen, carbon monoxide, and methanol are almost identical; kerosine vapor gives a slightly worse performance; and methane is substantially worse.

With all carbonaceous fuels there is a potential danger of depositions of solid carbon in the cells. This would block the gas passages and cause an inevitable loss of available energy due to irreversible, nonelectrochemical side reactions. With hydrocarbon vapors, carbon may be deposited due to thermal cracking. This occurs with propane, but not with methane or kerosine. It can be prevented by adding water vapor or carbon dioxide to the fuel gas.

Present laboratory cells have energy efficiencies of 78% at nominal ratings and 50% at mixium output, Chambers said. Thermal efficiencies will run about 60% at nominal ratings and 38% at maximum output.

The thermal efficiency is in agreement with General Electric's experience, said Dr. Herman A. Liebhafsky, in a paper prepared with Dr. David L. Douglas. A hydrogen-oxygen cell of GE's has obtained thermal efficiencies over 60%. Large models producing 10 watts and more are now under test in the company labs.

Within 5 years fuel cells using hydrogen should be ready for commercial use, he said. Fuel cells capable of competing with present power-generating equipment in central stations are not out of the question. When such types are finally developed, they will probably use gaseous fuels, particularly gases containing carbon compounds.

Present progress is gratifying, he said, but many formidable problems remain to be solved.

The Fuel Cell: What It Is

THE FUEL CELL is composed of an anode, cathode and electrolyte. It converts chemical energy of the fuel directly into electricity without combustion. However, the cell is not recharged periodically. Rather, it operates continuously, feeding off an incoming fuel (OGJ, Feb. 9, p. 72).

Conventional power sources, such as internal combustion engines or steam engines, convert the chemical energy of the fuel into heat and then convert a portion of the heat energy into mechanical energy or electricity. The fuel cell avoids this wasteful conversion of energy to heat. Thus, in principle, it can operate at about twice the efficiency of conventional power sources.

PIPELINE

The first application of a modified J-57 jet aircraft engine as a prime mover on a natural-gas pipeline will be made by Columbia Gulf Transmission Co. at its Clementsville, Ky., station. Columbia Gulf has applied for an FPC permit to install the 10,500-hp. prototype unit which will drive a specially designed Cooper-Bessemer power turbine and centrifugal compressor. Cooper-Bessemer Corp. and Pratt & Whitney Aircraft now have an experimental unit under test at East Hartford, Conn. (OGJ, September 7, p. 99).

A crude-oil gathering system in Reeves County, West Texas, has been completed by Pasotex Pipe Line. McVean & Barlow, Inc., had the con-

New Jet-Fuel Guide

. . . developed by Texaco may win industry support.

REFINERS may have a new yardstick to use in evaluating jet fuels—the L. N. or luminometer number. According to L. C. Kemp, Jr., research vice president of Texaco, Inc., the luminosity of a fuel has a direct bearing on its aircraft lifting power, flight range, engine life, and exhaust smoke on take-off.

Texaco has developed the know-how for making jet fuels with extremely low luminescence. This quality, Kemp said, reduces the number of incandescent molecular fragments that form on combustion and cause the exhaust gases to glow. These fragments give off radiant heat which can seriously increase hot metal temperatures inside a jet combustor without adding to engine power.

The more cleanly a fuel burns, the lower the luminosity. Aromatics and naphthenes produce more unburned carbon in combustion gases than do paraffins.

With Texaco's low-luminosity fuel, he said, combustors can be operated at higher temperatures without overheating, giving greater thrust per pound of fuel. The company has provided over 1 million gallons of high L. N. fuel for tests by aircraft engine manufacturers and by its own jet engine laboratories at Beacon, N. Y.

Most jet fuels, according to Kemp, rate between 45 and 65 L. N. Texaco is now able to produce fuels with L. N. of 135 and higher. The company foresees new economies in jet operation if engine makers design to take full advantage of low-luminosity fuels. Whether the L.N. becomes an important jet fuel specification will depend on the military and the airlines. As the customers, they will decide whether low-luminosity fuels are practical.

LPG Line Revised

. . . with Houston-New York project dropped in favor of line to upper Midwest.

PLANS for a $100-million Houston-New York LPG line have been dropped in favor of a line from West Texas to Madison, Wis., and Minneapolis-St. Paul.

The Missouri-Kansas-Texas Railroad, in announcing the revised plans, said the company had been unable to obtain throughput agreements for the proposed 2,500-mile line. Without such agreements it could not be financed.

The line was to have run along the Katy and New York Central railroads, and was backed by both companies. R. E. Thomas, Katy chairman, said his company would build the newly proposed project at a cost of $55 million.

"We already have letters of intent in hand, in the works, and promised for a throughput of approximately 22,000 bbl. a day," Thomas said. He is aiming for 30,000 to 35,000 bbl. a day.

The proposed system would start in the Midland, Tex., producing area and extend to McPherson, Kans., there dividing into branches to Minneapolis-St. Paul and Madison.

New Coal Act Dies

. . . when president refuses to sign. Revised bill urged.

PRESIDENT Eisenhower has refused to sign a bill which would establish a special coal research and development commission.

This was a distinct setback for the coal people who had pushed the legislation through Congress. Their goal was to institute further government research in an effort to find new uses for coal, increase old uses, trim coal costs, and, in general, help coal be more competitive with oil and natural gas.

The President, in rejecting the bill, pointed out that the Interior Department already has a research and conservation program for coal, as well as for other mineral resources. Establishment of the proposed commission, he said, would dilute Interior's interest.

Second setback . . . The bill is also undesirable, the President said, because it could serve as a precedent for creation of other such special agencies.

He did approve a provision of the bill which would authorize the Secretary of Interior to contract for coal research. He said he would urge Congress to enact such legislation.

The President's action was the second recent setback for the coal and coal-related industries. Earlier, the House rules committee had bottled up a resolution calling for establishment of a special congressional committee to draft a national fuels policy. It was apparent the coal industry hoped such a fuels policy would specify end uses of the nation's fuel resources.

BRIEFS . . .

tract for the 35 miles of 2, 4, 6, and 8-in. line.

A contract for approximately half of a 500-mile 8-in. products line from Teheran eastward to Meshed, Iran, has been awarded to Williams Brothers. The line will be an extension of the National Iranian Oil Co. products system. Construction timetable has not been set.

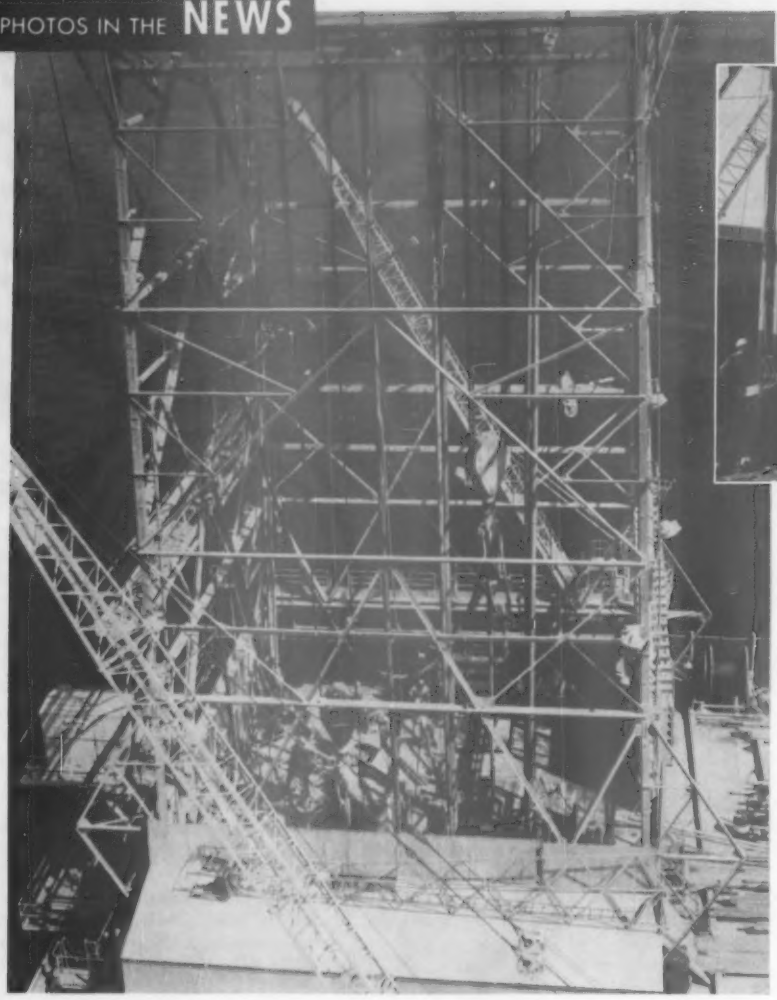
Construction has begun on the $4,000,000 Calgary, Alta., plant which Big Inch Pipe Mill will build to produce pipe from 18 to 36-in. Capacity will be 120,000 tons per year, with production scheduled to start in May 1960. Inter-Provincial Steel Corp., Ltd., is building a 110,000-ton per year steel mill in Regina, Sask., and will supply skelp to Big Inch. Another pipe mill is being built at Camrose, central Alberta, by Page-Hersey Tubes, Ltd., and Steel Co. of Canada.

A 22-mile 6-in. line now being built from Maysville to the Wynnewood, Okla., refinery of Kerr-McGee Oil Industries, Inc., will complete a link tying together Kermac refineries at Wynnewood, Cleveland, and Cushing, Okla. The new line ties into a line purchased from Magnolia. Finished products can be moved from Wynnewood to Cushing and Cleveland, or in the reverse direction. The various units at the refineries can be used as if they were in a single plant.

Also for Pipeliners . . .

IN THE NEWS: Pan American move highlights the new impetus being given to intrastate gas sales (p. 101) . . . Katy railroad revises plans for LPG pipeline. Route now goes from Midland, Tex., to Upper Midwest (p. 111) . . . Italy envisions network of pipelines to Central Europe with refinery tie-ins (p. 117).

PLUS THESE TECHNICAL REPORTS: Annual pipeline issue (pp. 124-207) . . . Using radioisotopes for interface detection in products pipelining (p. 227).



Seeing Double?

A UNIQUE operation is under way on Standard Oil Co. of California's platform off Summerland, Calif.—simultaneous drilling of two wells using the same derrick.

With draw works for each rig positioned on opposite sides of the platform, the rotary tables of the two wells are about 18 ft. apart. The derrick, 140 ft. high and 45 ft. by 45 ft. at the base, is designed so the crown blocks of each rig are spotted directly over the well being drilled.

Plastic Paving

SHELL Oil Co. has laid a stretch of paving with its new plastic-and-asphalt concrete, which combines epoxy resins with asphalt.

Shell developed the "almost indestructible" surfacing material to meet severe requirements of jet aircraft on runways and maintenance area pavements.

An initial application, however, is shown on an 868-ft. road leading to the Shell Chemical Corp. plant at Deer Park, Tex., near Houston.

No Vacancy

THESE are all lawyers—and it isn't a bar association meeting. They were among 84 attorneys in U. S. District Judge Royce H. Savage's courtroom in Tulsa during a pretrial conference of the Government's price-conspiracy case against 29 major oil companies. All but four of the lawyers represent the oil firms. They filled up most of the available seats and overflowed into the jury box. Spectators during the trial, which will start January 18, will have to show up early to get a seat.

Pioneers Honored

A MONUMENT—honoring pioneer developers of California's huge Ventura Avenue field—now stands on Shell Oil Co.'s Taylor lease north of the City of Ventura.

The monument specifically honors B. H. van der Linden, Shell pioneer who had a big part in the discovery of commercial production in the big field. Van der Linden, who died last year, formerly headed Shell's world-wide production operations.

The monument was erected by the Petroleum Production Pioneers. It was officially unveiled during dedication ceremonies by O. W. Chonette, right, of Texaco, Inc., and F. W. (Dutch) Schmieder of Shell. Chonette, president of Petroleum Production Pioneers, was master of ceremonies at the dedication.

Rx for Sick Service Stations

Dealers should:

- Determine money needed to operate station properly through slow periods of first year or so. This amount should be available above the initial investment in the station.
- Insist on getting best dealer training the parent oil company can offer. Do likewise for your employes after opening so they can also be trained.
- Erase any "chip on your shoulder" attitude toward the company. It spoils good business relations.
- Set up simple, easy-to-keep record system. Then check records daily, weekly, monthly to find profit or loss.

Companies should:

- Keep accurate termination records, interview a quitting operator, try to prevent heavy dealer turnover.
- Follow careful selection methods before putting a man into a new station and be sure he has the required training.
- Make it clear to new lessees that they must follow a record-keeping system suggested by company.
- See that salesmen do a better job of helping dealers solve their problems. Joint meetings of salesmen and dealers are one way to train dealers in latest methods of servicing customers' cars and in service-station management.

Why Do Service Stations Fail?

THE 30% mortality rate among service stations across the nation is one of the most acute and expensive problems facing oil-industry marketers.

A new study revealed last week sheds new light on the question. It reports that station operators go out of business because they:

... **Make too little** profit.

... **Have insufficient** working capital.

... **Keep inadequate** records.

... **Have too little** training for the work.

... **Get very little** specific help from oil companies.

These economic sore spots in the marketing section of the oil industry were discovered in an exhaustive study by Dr. Lloyd R. Saltzman of the University of Tulsa's marketing department and his 17-man class in market research.

The researchers interviewed more than 75 station operators who had quit business in the Tulsa area over the last 2 years. Oil-company representatives of the 11 parent companies whose stations were involved also were interviewed.

Chief complaints from the operators involved long hours of work, the frequent price wars, and lack of cooperation from oil-company suppliers.

Oil-company representatives, for their part, observed that many station operators who quit were discouraged by lack of working capital and poor management techniques. These they described as failure to do a balanced selling job and inability to plan properly.

Heavy loss . . . The turnover in station operators is costing the oil industry heavily.

Saltzman observed that despite the great sales potential of products and services sold in service stations about 3 dealers out of every 10 will leave their stations each year.

Often the same station has a turnover of two or more times a year while many stations have no turnover.

"Nevertheless the number of terminations is excessive," the researchers reported. "In each case the cost to the dealer and to the parent oil company is high and almost impossible to measure—when one considers the loss on the original investment, the loss during time that the station is closed, and cost of finding a new lessee and getting him started in the business properly.

Competition stiff . . . More than 70% of the operators who quit said they worked more than 70 hours a week.

Only 6% said they worked less than 60 hours a week.

Four out of every five operators interviewed keep their stations open 90 hours and over per week. The most-mentioned business hours were 7 a.m. to 9 p.m. Only five stations were kept open 24 hours a day.

The Saltzman report showed that 90% of the terminees leased their stations from oil companies rather than owning them. Nearly 80% had at least one competitor within a block and about 32% had three or more competitors within a block.

Saltzman pointed out there's a growing complaint from dealers that far too many stations are being opened. He said that reports from the U. S. Department of Commerce indicate that the number of service stations in the U. S. has increased by about 50% during the past 8 years. About 40% of the stations surveyed by Saltzman had been open less than 5 years.

The researchers found the average station had two bays and was from 5 to 9 years old. Average investment was between $2,500 and $4,999, and the average terminee sold from 10,000 to 15,000 gal. of gasoline during each of the last 2 months of operation.

Training . . . Only 16% of the operators had some type of formal training before or after they opened their stations.

Only six operators had training both before and after the station opening. On-the-job training was the most common type for those who received training before the opening. Transmission instruction and sales meetings were mentioned most for those who received training after the opening.

Oil-company salesmen called on the dealer once or more each week in more than half the cases. A common complaint from dealers, however, was that the salesmen too often made social calls only or that the salesmen high-pressured them into buying company merchandise instead of helping the dealer solve his problem.

Too, many dealers felt the salesmen were company centered and not really interested in the welfare of dealers.

As for bookkeeping, the most-mentioned system was the Penny Record which was used by about one-third of the operators. Only about 6% of the dealers followed a bookkeeping system suggested by the oil company.

Sixty per cent of the terminees reported they never intended to return to the service-station business. When asked what they would do differently if they went back into the business, 13.5% said they would work for an independent oil company.

Saltzman said the inference was that the men liked independents because of the lower price of gasoline (about 2 cents a gallon), the personalized service of the salesmen, and the chance to sell various products of their own choosing.

The company view . . . Nearly all the oil companies consider the gasoline gallonage sold as a basis for determining rental arrangements.

In most cases the lessees were allowed to choose the station location depending upon availability of the stations at the time.

Two-thirds of the companies required an initial investment of only $2,500 or less by the station operator. About four out of five companies allowed credit to dealers on purchase of oil and TBA products. But only 45% permitted the operator to buy gasoline on credit.

A tank of gasoline may cost over $1,500, and cash on delivery sometimes works a hardship on the lessee, the researchers reported.

As for company salesmen, most firms require them to have a college degree. They must call on dealers about once a week or oftener. Their main functions apparently are to help the dealer in merchandising, sales promotion, and solving dealers' problems.

Some company officials believed that the salesmen were not carrying out the work they were trained to do, and lack of detail work with the dealer was an important shortcoming.

Tidewater Calls Off Merger With Skelly

THE long-talked merger of Tidewater Oil Co. and Skelly Oil Co. bogged down last week for the second time.

George F. Getty II, Tidewater president, announced at the close of a board meeting September 17 that the latest merger plan was being dropped after more than 5 months of negotiations.

Getty said Tidewater had found no "present" basis for such a merger.

A merger of the two companies first was attempted in 1947. It brought strong opposition from W. G. Skelly, founder of the Skelly company, who defeated the plan in a bitter court fight.

John S. Freeman, Skelly president, said the decision to end current negotiations was made by Tidewater.

This was confirmed by Getty, who indicated the improved economic outlook for Tidewater made the merger unattractive.

Getty issued a statement which said:

"The continued improvement in operating results, the excellent net asset value indicated for Tidewater stockholders by merger discussions and by outside appraisers' valuations, show that in fairness to Tidewater stockholders a merger under current market conditions is not advisable.

"Tidewater's continuing program of expansion through capital expenditure is beginning to contribute substantially to earnings and Tidewater stockholders should have every opportunity to see the company's asset value and earnings reflected in the market price of their stock."

While the implications was that an exchange of stock would not be attractive at current market prices, actually no basis for exchanging stock had been announced.

Freeman said the Getty announcement means that Skelly "is just where it was last January." The company will go ahead in its operations "as if nothing had ever been said," he declared.

5 months old . . . The merger plan first was announced in April (OGJ, Apr. 20, p. 61) after years of rumors that the proposal was imminent.

In July Getty announced that "excellent progress" was being made toward the merger, although six committees at work on the proposal had not reached agreement on evaluation of properties and a mutually acceptable stock-exchange basis.

Tidewater had sold its Mid-Continent marketing facilities last December in what was generally accepted as a first step toward a merger.

It had also notified the Justice Department of its intent to merge and in early August had sent answers to 16 questions raised by the department.

If the merger proposal had been completed, the move would have created a company with assets totaling more than a billion dollars.

It would have given the combined company a better balance than either operating independently. Skelly has more crude-oil production than refining capacity, while Tidewater's situation is just the reverse.

With Tidewater's existing marketing and refining facilities on both coasts, and Skelly's refining and marketing in the Mid-Continent, the combined firm would have pretty well covered the country.

Oklahoma Independents Split

. . . by battle over increased allowables. New group seeks constitutional provision for 50-bbl. per well minimum.

A BATTLE over more generous allowables has split the ranks of Oklahoma's independent oil producers.

Arrayed against each other are the 4-year-old Oklahoma Independent Petroleum Association and the 4-week-old Oklahoma Independent Producers and Royalty Owners Association.

W. A. (Gus) Delaney Jr., Ada lawyer and oil man, is spearheading a campaign to write a clause in the Oklahoma constitution setting the minimum state oil allowable at 50 bbl. daily per well.

He and a group of other dissident independents organized the OIPROA to conduct a drive for 175,000 signatures to a petition calling for a statewide vote on the question. Delaney as president of OIPROA currently is waging a campaign for signatures over television, radio, and the press.

The OIPA, headed by Paul R. Schultz of Tulsa, has taken battle with Delaney's group. They are alarmed that a victory for Delaney would mean collapse of Oklahoma's conservation system and bring on market chaos.

Delaney's case . . . The argument being used by Delaney is that other states have higher allowable than Oklahoma.

He points to southeast New Mexico with 32 bbl. daily, San Juan-New Mexico 54 bbl., Louisiana inland 39 bbl., and Louisiana offshore 82 bbl.

Delaney says an Oklahoma well has to be 4,800-ft. deep before it can produce more than 14 bbl. daily. He argues that only five states have market-demand proration and two of these have higher minimum allowables than Oklahoma. All the other states without proration have no production limits.

"What's wrong," he asks, "with the small producers and royalty owners of Oklahoma getting their share of the market?"

The other side . . . Schultz is concerned that such a big jump in the state's allowbale would break down Oklahoma's marketing system.

He sees it as an attempt to force crude buyers to take more Oklahoma oil.

"In my judgment," Schultz says, "it is not sound business practice to force a person by law to buy more goods than he can economically use. If the allowable is set at a 50-bbl. minimum, this in effect is an attempt to force crude oil purchasers to take that amount of oil.

"This could only mean that the purchasers would begin prorating the taking of oil. The large producing wells would be allowed to sell their 50 bbl., but then the small producers would be cut off without any market at all.

"This would eventually drive hundreds of small oil men out of business. It would affect not only them but also royalty owners, other oil services, and state revenue.

"Some of the producers undoubtedly would have to look outside the state for a market. An Oklahoma action of this sort undoubtedly would lead to increased allowables in the other states. Soon there would be chaos, as I see it."

Schultz, who is president of Blackwell Oil & Gas Co., admitted that the market for Oklahoma crude has declined like that of other oil states. He said this apparently was due to heavy imports and added that action such as Delaney proposed would upset corrective measures now being taken.

Reaction from Texas . . . Jake Hamon, prominent Texas independent, took notice of the Oklahoma fight in addressing the Houston meeting last week of the Texas Mid-Continent Oil and Gas Association.

He said the association backers "like Samson are going unwittingly to destroy themselves to call attention to their plight."

Hamon also declared the pressure against low allowables is "just a forerunner of what we can expect to develop all through the Southwest unless the matter of inventory control is taken away from the refining branch and put in the hands of top management."

INDUSTRY BRIEFS . . .

Name of the 29-story Magnolia Petroleum Co. building in Dallas will be changed October 1 to the Mobil building. The change coincides with Magnolia's becoming a part of Mobil Oil Co., a division of Socony Mobil Oil Co., Inc. The Flying Red Horse sign will continue to rotate atop the structure. When the building was built in 1921, it was the fourth highest in the U. S., outside New York City.

Columbia Gulf Transmission Co. has purchased a 10-acre site in Houston to erect a headquarters building. The site is located on West Alabama Avenue. Columbia Gulf's offices now are at Brazos and Dallas Avenues.

Producing properties of the recently-dissolved Brinson-Collins Oil Co. of Midland, Tex., have been purchased by United Carbon Co. through its gas subsidiary, United Producing Co. The properties include 66½ net wells located in the Welch, Itaan-East Howard, Furhman-Mascho, and Coleman Ranch fields in West Texas.

Consolidated Oil & Gas, Denver, has acquired operating interests in nine producing Dakota gas wells in San Juan County, N. M., and in 23 producing oil wells in the Post Glorietta field of Garza County, Tex. The company plans a 10-well development program in the Garza County area.

A three-man commission to administer Nebraska's new oil and gas conservation act has been named by Gov. Ralph Brooks. Members are G. H. Doran, Sidney; Fred Enders, Kimball; and Ray L. Smith, Chappell. Doran is in the abstract and investment business, Enders is with the Smith-Enders Land Co., and Smith is an attorney in the firm of Smith & Wentz. The new conservation law becomes effective next week.

Spur Oil Co., Houston, will purchase a gasoline plant in Hull field, Liberty county, Texas and spend $1 million rebuilding it and laying a 12-mile pipeline system. The plant now processes from 3 to 5 million cubic feet of gas daily. It will be enlarged to handle 10 million cubic feet. Spur acquired the plant from Mrs. Katrine Low West, Houston. Southwest Industries, Inc., will do engineering and construction work.

Italy Envisions Network

. . . of pipelines to Central Europe with refinery tie-ins.

Others also have pipeline projects under consideration.

ITALY'S dynamic Enrico Mattai intends to get in on the ground floor of Europe's blossoming pipeline network.

The president of the government's oil monopoly, ENI, says his corporation will build a system northward from Genoa that will move 240,000 bbl. to 280,000 bbl. of crude daily to refineries in northern Italy, Switzerland, and southern Germany.

The plan dovetails with other moves by Mattai, whose avowed purpose is to make ENI an international oil power. He fully expects to have big-scale crude production through ENI's concession interests in Iran and Egypt. A pipeline system to central Europe with the necessary refinery tie-ins would give ENI a needed outlet for this crude.

The Genoa pipeline project has been in the works for months. But Mattai spelled out plans at a time when at least two other groups were studying their own projects to Munich, one of the key cities in Mattai's scheme.

One rival project is being studied by another group of Italians, although Mattai may have a hand in it. It involves a line from Venice to Munich via Austria. The other proposal, being considered by a joint American-Saudi Arab group, is a system to the southern German center from an unspecified Mediterranean port.

Genoa plan . . . The Italian Government has already approved part of the project, a 250-mile trunk from Genoa to Aigle, Switzerland.

The program now calls for an overall system of about 700 miles. The main trunk is to be extended 135 miles past Aigle to the West German frontier. There it will split, with a 145-mile branch to Munich, and a 94-mile branch to southwest Germany. In Italy, feeders will be built to Turin, Milan, and Cremona.

Mattai foresees refineries at both German terminals, together with petrochemical developments, fed by lines with capacities of 80,000 bbl. to 100,000 bbl. daily. A 40,000-bbl. plant is planned for Aigle, and facilities in northern Italy will be expanded to handle 60,000 bbl. daily.

The plan is not without its headaches. The Italian-Swiss treaty may have to be changed if the line passes through St. Bernard tunnel, as contemplated.

Mattai has some financial backing from Italian and German banks. But he hinted that ENI might take international majors as partners.

Venice plan . . . The plan for a 60,000-bbl. pipeline system running northward from Venice is part of a package deal that would include a highway and refinery building program.

A $166-million scheme being promoted by the Barnabos group calls for a 240-mile turnpike from Venice to the vicinity of Innsbruck, Austria, via Brenner Pass. The pipeline would be laid along the highway. In return for cutting the highway distance to Innsbruck by one-third, the group is seeking the right to build a refinery there with tax advantages. The system could then be extended to Munich.

Another project is under study by an American pipeline builder and a Saudi Arabian citizen. The proposal reportedly would include preferential treatment of Saudi Arabian crude supplied to Munich.

Other systems . . . Mattai's move points up the important place crude pipelines have taken in the European oil picture almost overnight.

A 230-mile 28-in. pipeline from Wilhelmshaven to Cologne opened early this year with a capacity of 200,000 bbl. daily. A 150-mile 24-in. line into the same area from Rotterdam will open next year with a capacity of 150,000 bbl. daily. The lines will eventually carry a combined total of nearly 1 million barrels daily.

A group of 19 international and local European companies expect to open a 460-mile system from Marseille to Karlsruhe, Germany, by the end of 1962. Initial deliveries of 160,000 bbl. daily will be stepped up to 500,000 bbl. daily later. The line will be 30 in. most of the way.

When the Marseille-Karlsruhe system is completed, the only gap in a contemplated trans-European pipeline will be the section from Karlsruhe to the Ruhr.

BATTERY of big lines funnels crude from storage to Mina al Ahmadi tanker terminal.

Pint-Sized Kuwait Has Some Texas-

HEAVY wire fences and coiled barbed wire protect all Burgan wells. Protection was added after a few wells were sabotaged during Suez crisis.

Paul Swain
International Editor

IN KUWAIT, where the fantastic is commonplace, production people grudgingly concede that new fields like Raudhatain and Minagish are interesting, but always with the reservation that Burgan is Kuwait Oil, with a capital "O."

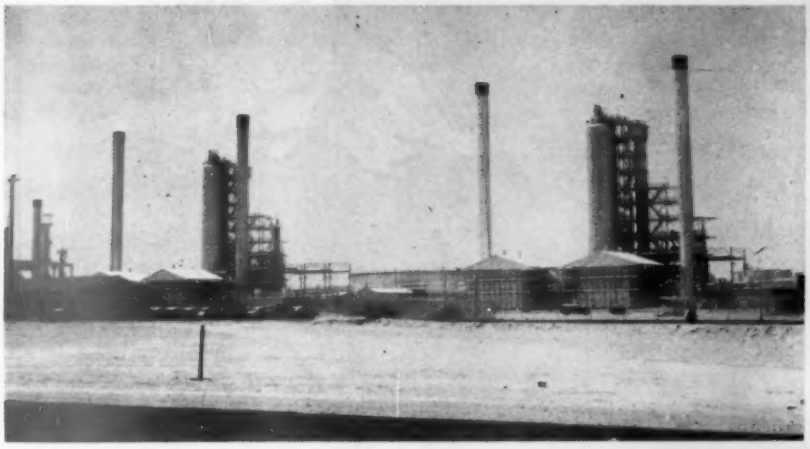
Burgan, the 1938 discovery, is the backbone of Kuwait. The size of its vertebrae makes any argument useless. Burgan has furnished the bulk of the more than 3,400,000,000 bbl. of Kuwait crude that has been shipped from the shaikhdom in little more than a dozen years.

Early this summer the big Burgan field, along with the newer, smaller Magwa-Ahmadi, poured a little more than 1.5 million barrels daily into the storage that serves the Kuwait loading terminal. This not only didn't strain the big field, it hardly let it flex its muscles.

In short, everything about Kuwait's oil is best expressed in superlatives. Kuwait is enough to make a Texan blush with shame.

The country has the biggest oil loading terminal in the world. Its storage capacity of a mere 9.8 million barrels isn't bad either. It's no joke, nor is it exaggera-

BURGAN FIELD supplies bulk of Kuwait's 1-million-barrel-plus daily production. The field has several gathering stations capable of handling 140,000 to 180,000 bbl. of crude daily.



MOST PROMINENT features of Kuwait Oil's 190,000-bbl. refinery are the twin 80,000-bbl. crude distillation units. The only downstream processing is a 400-bbl. asphalt plant and a Platformer.

Sized Oil wells

tion, to say that 1.5 million barrels daily production doesn't let the country's oil flex its muscles. Kuwait has a field separation capacity of 2.3 million barrels daily; a field pumping capacity to match that; and a production capacity of 2.85 million barrels daily from existing wells and production facilities.

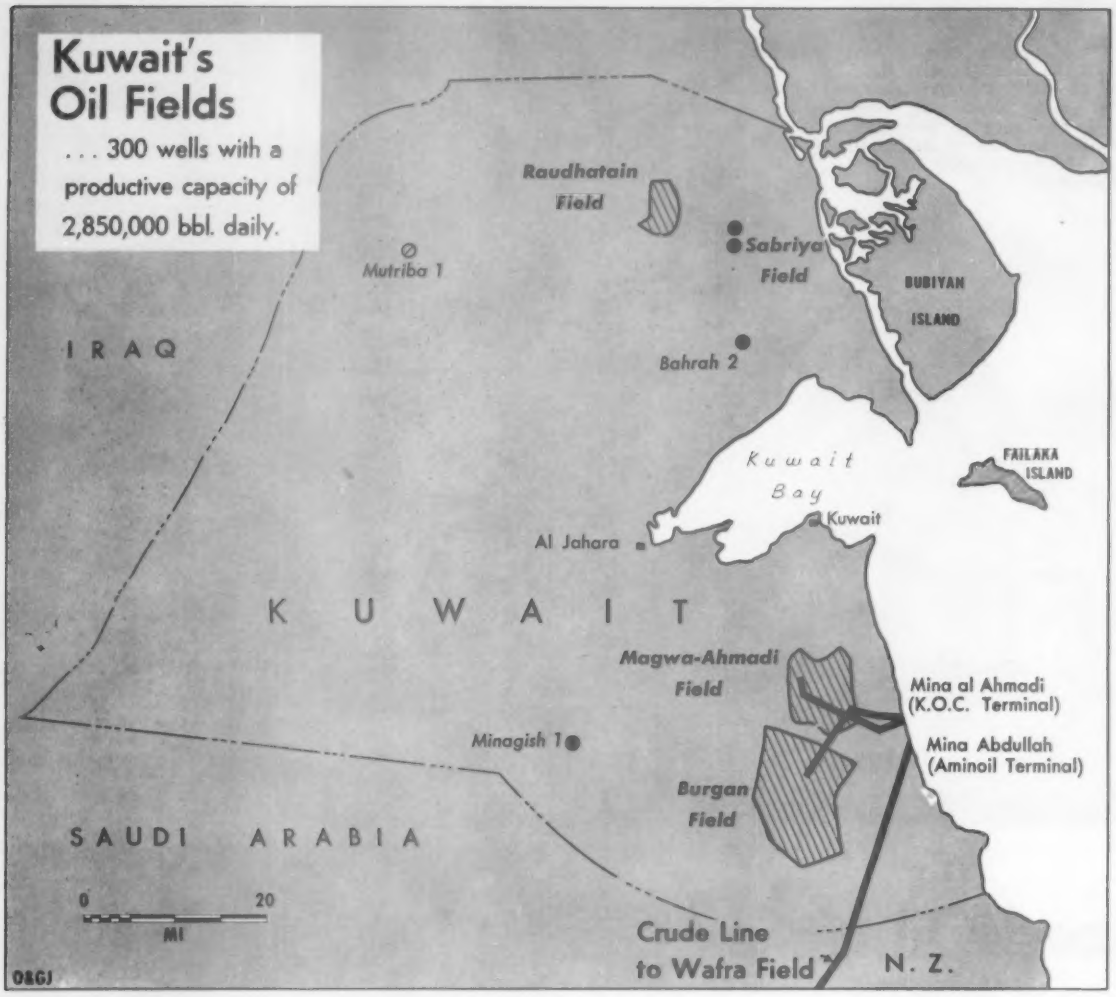
Anything less than a 6-in. flow line is frowned on in the field and there aren't many wells that have one smaller. The collecting lines from Kuwait's separators are double 12-in. Lines to storage on the heights above the country's big loading terminals range from 20-in. to 34-in. with 1 mile of 36-in. crude line included.

About all that keeps Kuwait from taking over the No. 1 oil-exporting spot from Venezuela is a world-wide depressed crude market. Kuwait could come pretty close to matching Venezuela's 9,200-well output from only 300 wells. And, those wells are grouped in three fields in a stretch of sandy desert that literally could be lost in Eastern Venezuela.

Fourteen of Kuwait's separator-pump stations serve Burgan and the Magwa-Ahmadi fields. Output of these stations ranges from 140,000 bbl. daily to 180,000 bbl. daily each.

A fifteenth station equipped with three 900-hp. Ruston & Hornsby turbines in series and Mather &

BIGGEST oil loading terminal in the world is located at Mina al Ahmadi. The terminal has whopping storage capacity of 9.8 million barrels.



Platt pumps can move 200,000 bbl. daily from Raudhatain field in North Kuwait.

Storage and terminals . . . All this productive capacity moves into two tank farms with a combined capacity of 9.8 million barrels of crude.

The old South Tank farm serves the Mina-al-Ahmadi terminal, the world's largest. It consists of four 139,000-bbl. tanks; twenty-five 168,000-bbl. tanks; and six 210,000-bbl. tanks located on the heights above the big 10-berth pier.

The new North Tank farm has one 210,000-bbl. tank and fourteen 262,000-bbl. tanks located on a bluff 375 ft. above the North pier. Three 40-in. gravity flow lines extend to the new 5-berth pier.

In addition to the two piers, there are six offshore sea berths for tankers loading products from Kuwait's big 190,000-bbl.-daily refinery. This product loading is almost entirely bunkers. The only downstream facilities the mammoth crude-distillation plant has are a 400-bbl. asphalt plant and a brand new 4,000-bbl.-daily Platformer which went on stream only a few weeks ago.

Gas reinjection . . . Following the world-wide trend that has spread to the Middle East, Kuwait will start reinjecting gas into its producing formations by the end of 1960.

At present gas from the separators that can be used in Kuwait town and Ahmadi for domestic and industrial use goes to these two sources. But the amount is small. The remainder is flared in the desert as waste.

Kuwait Oil Co. is now building a new injection plant in Burgan to put 100,000 M.c.f. of this flared gas back into formation. Initially, the company will have only five injection wells. The 395-psi. gas will be stepped up to 1,920 psi. in two-stage compression and reinjected.

The injection plant will be equipped with two 7,000-hp. Westinghouse simple-cycle, single-shaft gas turbines powering two Ingersol-Rand centrifugal compressors in series.

The units will be equipped with small starting turbines operating on 395-psi. gas. The units are being equipped with all automatic and shutdown controls. The new plant was designed by Brown & Root, Houston, and engineered by the KOC London offices. Kuwait Bechtel Corp. is building the plant.

Local consumption . . . The tiny little desert kingdom

of Kuwait probably has the highest per capita gasoline consumption of any country on earth.

The most casual observation shows why. Kuwait's dusty, sandy countryside and villages are liberally sprinkled with new, two-tone, high-compression automobiles and trucks. Most of them are American. It's not at all unusual to see a bright red-and-white American sedan or station wagon parked beside a Bedouin tent at a remote desert spot with camels and goats grazing all around it. Dozens of shiny new station wagons thread in and out the ancient gates of old Kuwait town, most of them looking a little topheavy with a luggage rack full of bundled alfalfa to feed the driver's livestock.

This mass of automobiles gives Kuwait an eerie mixture of ancient and modern appearance. It has also given the little country a common ailment of the automobile age—the traffic problem.

More important, it has given the country a domestic fuel consumption pattern that is almost the exact reverse of any nation east or west of the United States.

Last year Kuwait drivers used 34 million imperial gallons of gasoline (about 2,700 bbl. daily). About 70% of this was premium auto fuel, but the heavy use of premium can be misleading. Premium gasoline is about 90 octane and is blended for local consumption from imported cat-cracked gasoline from Abadan.

In contrast to this heavy gasoline use, Kuwaitis used only 6.7 million imperial gallons of kerosine (about 524 bbl. daily) and 12.2 million imperial gallons of gas-oil (about 954 bbl. daily).

Oil wealth that has trickled down to the populace and a thriving, bustling private economy have created this desert automobile age. It is helped a great deal by the fact that Kuwait's 11 privately operated service stations market their premium gasoline for the equivalent of 16.5 cents a gallon. The 70-octane regular costs only 10.5 cents.

Another Strike Is Made Deep in the Sahara

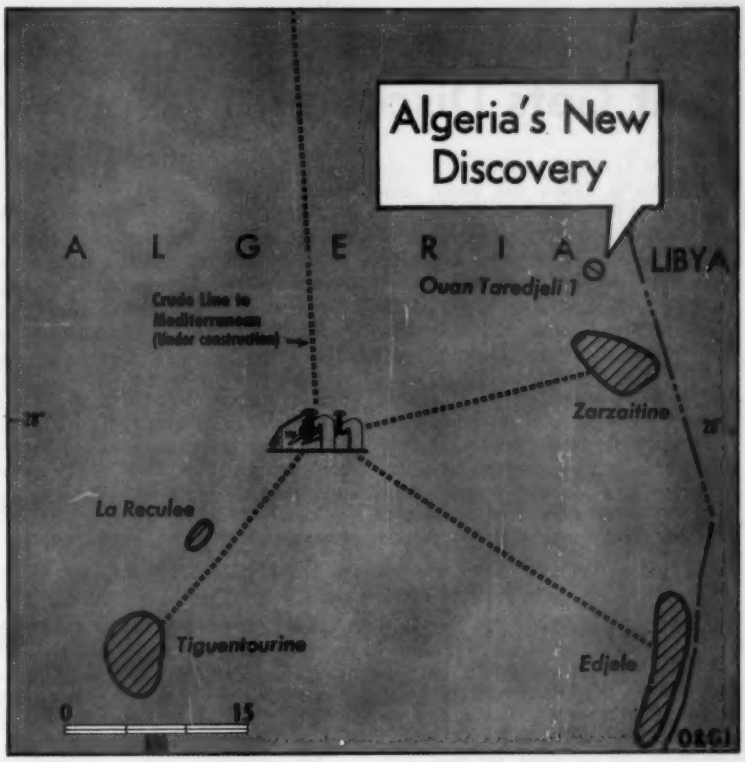
- CREPS discovery has five possible pay zones. It's in Edjele area near Libya.

EASTERN ALGERIA'S prolific Edjele region has yielded another discovery.

Ouan Taredjeli 1, 8 miles northeast of Zarzaitine oil field, has encountered five known zones which tested oil or gas, or both. CREPS, the concession holder, is still deepening the hole, drilling ahead at 3,670 ft.

Gas was encountered first in the B-2 zone, from 2,100-33 ft. Oil flowed at the rate of 31 bbl. per hour in the B-4 horizon, from 2,280-2,345 ft. The B-6 zone yielded 6 bbl. an hour from 2,375-2,405 ft. The B-8 formation tested gas and water between 2,450-2,500 ft. The D.O. reservoir flowed 14 bbl. per hour from 3,115-80 ft.

The find is on a structure extending in a north-northeast direction. It is blocked from Zarzaitine by a series of faults.



Low-cost wells . . . CREPS has developed 900 million barrels of recoverable reserves on its concessions nestle against the Libyan border.

A 460-mile, 24-in. pipeline from the producing area to La Skhirra, Tunisia, is expected to open next year with an initial throughput of 150,000 bbl. daily. Zarzaitine, with an estimated 600 million barrels of recoverable reserves, will produce the lion's share. But several other discoveries in the area may have commercial possibilities. These include La Reculee, El Adeb Larache, Ouan Taredert, Collenia Domeo Haaraet, and southernmost Ikebrane.

Despite a per well yield much smaller than that of Hassi Messaoud production, some observers think CREPS properties are a better commercial bet. The depths are shallower and the permeability and porosity of the reservoir rock are higher. Completion costs may be only one-thirteenth as much as for Hassi Messaoud.

CREPS, owned 35% by Royal Dutch-Shell, said in Paris this month that it will need to invest another $250 million to complete field development and the pipeline to the Mediterranean. The company has started negotiating with French refiners for a permanent outlet for its crude, some of which is expected to reach world markets through the Shell organization. Production in 1961 is slated to average 160,000 bbl. daily.

Philippines May Have First Commercial Find

- Redeco says its Cebu wildcat has five productive zones.

Company plans to skid rig to new location for an offset.

A LOCALLY-OWNED Philippine exploration company has made what appears to be the first commercial oil discovery in the islands.

Republic Resources & Development Corp. has made two successful drill-stem tests of its shallow Cebu wildcat. The company says it has found at least five productive zones in the well, 30 miles west of Cebu City.

The first test, 2 weeks ago, yielded 449 ft. of clean 41° to 45°-gravity oil from a section found between 1,107-91 ft. Gas flow from this interval was estimated at 70,000 cu. ft. daily.

Attempts to test the interval further failed when the packer wouldn't hold, so the well was deepened to 1,285 ft.

The second test made last week of the 1,257-84 ft. zone was even better. Gas reached the surface almost immediately, and the company recovered 50 ft. of heavy oil and gas-cut mud in addition to 754 ft. of "high gravity, free oil." Shut-in pressure of the well was 200 psi.

Redeco plans to skid the rig to an offset location for a second well.

The Cebu discovery is the first which appears to be commercial in the Philippine Islands. Previous exploration has pretty well centered in the Cagayan Valley of northern Luzon where deep tests have been drilled, all with at least some shows of oil or gas.

Shallow drilling was done on Cebu more than 60 years ago. A 500-ft. hole drilled on Cebu in the early 1900's still yields about a barrel a day of bailed crude (OGJ, Sept. 1, 1958, p. 120).

Panay's wildcat . . . Two companies have started a well on the south coast of Panay Island.

Philippine Oil Development Co. (Podco) and San Jose Oil Co. plan to take Tabbauan 1 to about 8,000 ft. The location is on the crest of a seismic structure 3 miles south of Oton 1, a 6,354-ft. test drilled by Podco 6 years ago. Oton encountered oil shows in sections between 3,926-6,019 ft., and located a potential reservoir rock from 5,118-88 ft.

Podco has a 70% interest in the 13,000-acre unit with San Jose holding a 30% net profits interest in the well and license. San Jose is a 75% owned subsidiary of Pantepec Oil Co. C.A. and Pancoastal Petroleum Co. C.A.

Gulf Gets Discovery in Northwest Libya

A DISCOVERY by Gulf Oil Corp. in northwest Libya has been completed as a 900-bbl.-daily producer.

Emgayet 1 is 200 miles south of Tripoli in the central part of concession 66. The pay zone, encountered at about 4,700 ft. last May, initially tested at the rate of 750 bbl. daily of 35°-gravity crude. The hole was bottomed at 7,944 ft.

Libyan oil men call the discovery "a nice little well." But much more drilling will be needed before the company can evaluate reserves. The first stepout, B1-66, located 5 miles from the first test, has been abandoned at 4,700 ft. The company is now rigging up for a second stepout, 8 miles from the find.

Half of the camp at Emgayet is being moved 47 miles west-northwest to provide facilities for the company's second wildcatting operation on the 7-million acre concession. The new test, D1-66, will probe a different structure.

Another well in the same general part of the country, Libya Shell's Bir Tlacsin 1, is plugging back from 13,187 ft. in preparation for upper zone testing. The find is 120 miles southwest of Tripoli.

Esso program . . . The second stepout to the Zelten discovery in northern Libya has been started by Esso Standard (Libya).

Zelten 3 is 5.4 miles southwest of the initial wildcat which came in at 17,500 bbl. daily to establish Libya as a major oil province. Zelten 2, located 4 miles southeast of the discovery, has been completed and shut in.

After completion, the well was opened to clean itself out. But no estimate of flow rate was made because the storage tank had been moved off location. The well on an initial test flowed at the rate of 15,000 bbl. daily from Paleocene limestone (OGJ, Aug. 24, p. 64).

Refineries Are Scheduled for Four Foreign Countries

PLANS for construction of refineries in four foreign countries are firmed up or in the mill. The plants are slated for Denmark, the East African country of Kenya, Morocco, and the Philippines.

Tidewater Oil Co. will build a 20,000-bbl. refinery at Kalundborg, an industrial seaport on Denmark's Island of Zealand, about 62 miles west of Copenhagen. It will be Denmark's first crude-oil refinery.

A Danish firm, Dansk Veedol, has been set up by Tidewater as its operating company there. The refinery probably will be on stream in 1961. It will help stem the trend of reliance by Scandinavian countries on Russia for their petroleum needs.

An agreement for a refinery in Kenya has been signed by Royal Dutch-Shell and British Petroleum Co. The $45-million plant is expected to open in about 4 years. It will be located in Changamwe industrial area of Mombasa and operate on Persian Gulf crude.

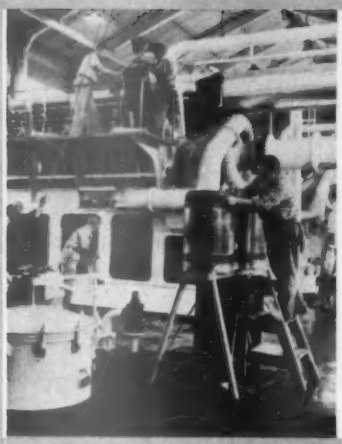
At the insistance of the Kenya Government, provision was made for other companies to join the project.

A 22,500-bbl. refinery will be built in Morocco by Soc. Samir, a company owned 50% by ENI, the Italian oil agency. The plant will be built under an agreement which gave Samir exploration permits in Tarfaya province.

The Philippine Government has approved a proposal for a 10,000 to 17,000-bbl. refinery to be built by Gulf Oil Corp. and local interests.

A new company, Filoil Refining Co., has been set up for the venture. It is owned 25% by Gulf Oil, and Philippine interests will hold the remainder. The refinery will be the country's fourth plant either planned or in operation.

PIPELINING... '59

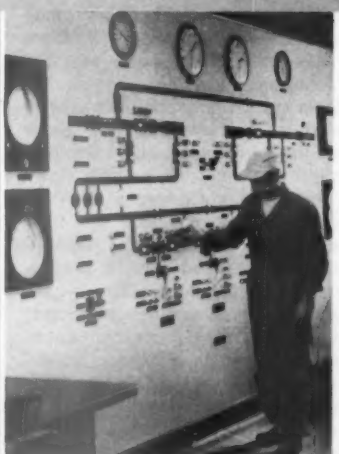


PLANNED MAINTENANCE that saves money and promotes reliable operation is the theme of the Journal's Annual Pipeline Number, which has a 31-year tradition of presenting know-how articles of significance to the industry. It leads off with a 15-page special report on maintenance, prepared by the Journal's Pipeline Editors from an industry-wide survey of top pipeline men (p. 124).

This special report is followed by an article on low-hydrogen electrodes for hot taps and a new joint design to assure full-penetration welds (p. 171) . . . A new instrument which promises improved engine balancing, lower fuel consumption, and lower maintenance is described (p. 182) . . . Lubrication advances are outlined in the report of a big transmission line's experience (p. 184) . . . And mechanical developments and maintenance ideas which have been the key to automation are analyzed (p. 196).

CONSTRUCTION continues to command major attention in the expanding pipeline industry, and contractor's methods are described in two of the year's more important projects. Pipe was laid at extremely rapid rates—almost 5 miles per calendar day—by a single spread on the Kaneb products-line expansion. The contractor obtained fast production by using two pipe gangs (p. 204) . . .

The Midwestern gas line, a 350-mile 30-in. line from Portland, Tenn., to Joliet, Ill., the largest new project of the year, used plastic coating for part of its exterior corrosion protection, internal coating for nearly its entire length, and some different approaches to field construction (p. 207) . . . And unusual construction requirements were met in laying jet fuel and avgas lines to Love Field in Dallas (p. 158) .



DESIGN AND OPERATION are covered in four outstanding articles. Laurel Pipe Line has developed a hydraulic nomograph for quick selection of pump combinations for power savings. Step-by-step use of this valuable tool is made crystal clear by elaborate color illustrations (p. 140) . . . Pure's experience in automating an old crude line will be helpful to others involved in this common problem (p. 144) . . .

Humble has design and operational innovations in the Love Field system: separate internally coated lines for avgas and jet fuel with rubber balls at interfaces (p. 158) . . . The behavior of gas-engine reciprocating compressors is explained by an expert who probably has no peer in this field (p. 201).

Together these articles offer 50 pages of rewarding reading for all pipeliners, whatever their special responsibility.

2 New Wall Maps... showing the nation's crude-oil lines (on one side) and products lines (on other side), and locations of more than 300 refineries.

Pipeliners report on

MAINTENANCE

This roundup presents what's interesting and important to top pipeliners in new ideas, new tools, and variety of approaches to problems.

BY PAUL REED AND GENE KINNEY
Pipeline Editors

CONSIDERABLE change has taken place in recent years in the maintenance practices of oil and natural-gas pipelines. Pipeliners themselves have been responsible for some of the innovations. They also have borrowed liberally from other industries.

And the period of change is not yet over, but is likely to continue for years to come, because machinery and operating techniques are changing. Maintenance appears to command more attention from management and operating personnel than heretofore. The era of "fix it when it breaks" has gone; it has become a casualty of a better understanding of the economy of planned maintenance and the requirements of the age of automation.

As change is the key word in maintenance trends for the entire industry, it is variety that characterizes practices within the industry. These are the facts that stand out in a survey of pipeline companies whose replies were followed up by dozens of interviews by the pipeline editors of the Journal.

This special report is the product of sifting from these sources the ideas which the men who are responsible for pipeline maintenance find to be most interesting and important. It is, in effect, a special report from the pipeline industry to the pipeline industry through the Journal.

The scope ranges from new tools and ideas to methods of handling special problems, and different approaches to the same problem. Practices are detailed for pumping and compressor stations, pipelines, and storage tanks.

1. Pumping and compressor stations

BEST EXAMPLE of change and variety is in the overhaul policies as applied to pumping machinery at crude-oil and products stations. They are different also from compressor-station practices, which will be described later.

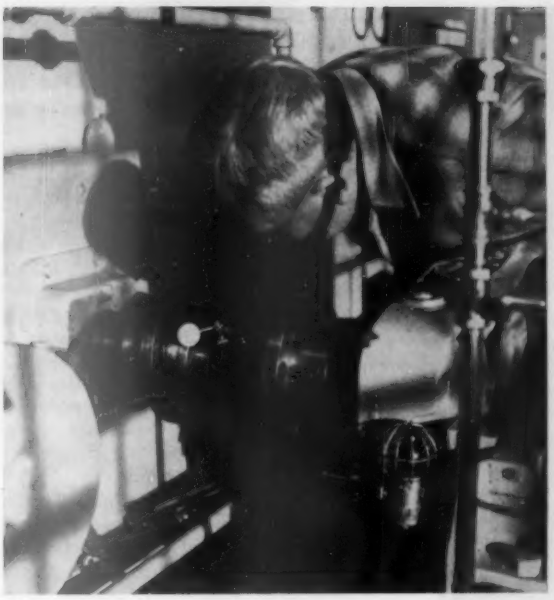
Pump-station policies . . . Regular major overhauls, once the standard procedure, have been abandoned by 60% of the crude-oil lines and 80% of the products lines. Preventive maintenance, involving regular inspection and minor repairs to avoid major breakdowns, is practiced on all the products lines and more than half the crude-oil lines reporting to the Journal.

One major crude system has a general program of regular overhaul for large engines but not for smaller engines. Pumps and electric motors are overhauled by this same company at irregular intervals. Another large crude system and a products system base overhaul intervals on actual hours of operation. The crude system's average for engines and pumps is 30,000 hours before overhaul. Another approach is to run engines until lube-oil consumption or some other indicator signifies trouble.

A company with both crude-oil and products line operations suggests different approaches for the different operations. It follows a "happy medium" between regular overhaul and overhaul only when there is evidence of a need.

On the crude system, machinery is overhauled only as the need arises. The seasonal load is not critical; therefore, loss of a station would not as a rule be as serious as on a products line. Pumping machinery on the products system is overhauled annually in order to have it in top shape before the winter load hits. The purpose is to forestall all possible down time during peak demand.

Overhaul plan . . . A large products system with several engine stations has recently placed in effect a program to overhaul engines when they have logged 16,800 operating hours. Overhaul intervals will range from 2 years to 5 or 6 years. Previously engines were overhauled at 8,400 hours regardless of their condition and performance records. The new program is based on regular inspections for each engine, complete records of the performance by the mechanic in



SHAFT ALIGNMENT is checked between the speed increaser and the pump with a dial test indicator that is accurate to 0.001 in.

GRINDING VALVE SEATS in cylinder head is done preparatory to installing reconditioned valves on a diesel engine.

charge of the engine, and a graph depicting its performance.

The graph provides a continuing picture of lube-oil consumption, pressure drop across the lube-oil filter, lube-oil filter changeout frequency, compression and firing pressures, crankcase pressure, and intake-air header pressure. Excessive lube-oil consumption, filter changes, erratic compression, and firing pressures are signals for overhaul inspection before the scheduled 16,800-hour overhaul. Many of the engines, all operating on No. 1 diesel, make the 16,800-hour goal without major trouble. Few actually break down.

The plan which this company has found to be very successful for its machinery and operating conditions includes a mechanic's inspection every 700 hours of operation. After 2,100 hours, a more complete inspection is made (little disassembly but a shaft-alignment check and closer crankshaft inspection). After 4,200 hours, there is an inspection which is more complete still (includes all previous inspections plus complete crankshaft deflection and bearing-clearance check, with removal of all inspection doors, windows, and covers to look at liners, etc.). This cycle continues until 16,800 hours have been logged by an engine. Any major or minor repairs indicated by periodic inspections are made.

The overhaul inspection requires from 56 to 72 hours. The job is done by three mechanics with the aid of station operating and maintenance-gang personnel. Possible trouble spots which could not be checked in previous inspections will be checked.

Machinery is disassembled and rebuilt completely. All parts subject to wear are removed for inspection. Engine lube-oil piping, crackcase, and coolant system are cleaned. Cylinder heads, pistons, valves, turbochargers, lube-oil pumps, and water pumps are replaced by reconditioned parts. The worn assemblies are reconditioned for use in the next overhaul. The overhaul applies to the engine, speed increaser, and pump.

Improvements cut costs . . . The cost of maintenance on engines and the down time for repair, once big deterrents to engine use, have been reduced greatly in recent years. There are better materials in rings, bearings, and liners, better instruments to protect engines, precision replacement parts, and quality control. Filtration of fuel and lube oil is improved. Lube oils themselves are much better.

Careful design for proper loading is one of the most important developments which have contributed to lower maintenance. Routine inspection and preventive maintenance, combined with these improvements, have extended the time between major overhauls by several thousand hours. A life of up to 15,000 hours or more without overhaul may be expected. One engine manufacturer reports that its modern engines in pipeline service average 98% availability, excluding scheduled overhauls.

Chrome plating of cylinder liners has become an important source of saving for some companies, although many have not adopted the practice and are not convinced of its economy. A pipeline which is perhaps the largest user of engines in the industry has a policy of replacing cast-iron liners with chrome-plated liners as needed. Eventually, the company plans to have 100% of its liners chrome plated. Where cast-iron liners are used, case-spun iron rings faced with chrome are installed.

The company states that chrome plating costs only 60 to 85% of new replacement liners and plated liners give three to five times the length of service. On the other hand, many companies prefer to buy new liners on grounds they are inexpensive and chrome liners are not justified. Some companies use special seal-oil rings which permit the continued service of a liner even after it has had considerable wear.

New tools and modifications . . . The industry has taken advantage of a variety of new tools, improved materials and equipment, protective devices for pumps, motors, and engines. And it has developed new tools and modified existing ones to reduce maintenance. Among those reported in the Journal survey were:

. . . Covers to keep rain water out of gear boxes on rising stem valves.

. . . Special liner pullers.

. . . Hose and pipe connections that are quick coupled.

P.D. METER parts are periodically checked for wear to maintain accuracy.

. . . Special valve-grinding equipment.

. . . Cylinder ridge reamers.

. . . Cylinder hones.

. . . Special mechanical-seal installation tools.

. . . High-pressure test equipment on pump cases.

. . . Special shaft-aligning fixtures.

. . . Heavy air impact wrenches.

. . . Hydraulic power wrenches.

. . . Instrument-calibration equipment to set automatic controls.

. . . Modified motor and pump bearings.

. . . Modified stage pieces in pumps.

. . . New procedure for installing valve-seat inserts to increase seat life many times (involves boring out original seat, cast as integral part of the head, and installing hard inserts).

. . . Modified rocker boxes to adapt diesels to dual-fuel operation.

. . . Use of premium fuels to reduce fuel-injection-equipment trouble, lengthen filter life, reduce lube-oil contamination, reduce ring sticking, promote cleaner combustion chamber, lessen exhaust-valve porting buildup.

. . . Cut oil grooves in motor bearings whose original design called for plain bore.

. . . Changed split-line clearance to make it adaptable for grooving in bearing.

. . . Installed preloaded duplex bearings in pump to replace single double-roll thrust bearings, to eliminate bearing failures where there have been problems.

. . . Using temperature method of taking centrifugal-pump efficiencies. This method has been used with varying success. For one company it has proved very effective. For another it has been ineffective because of the uncertainty of measurements. To get reliable results in determining standard differential temperatures and the significance of divergence from them, the tests must be carefully made by a technically trained man.

. . . Use of aluminum pistons which can be regrooved and rebanded to extend life. One company starts with a ring with ⅛-in.-wide face, regrooves the piston when the groove wears to 5/32 in., regrooves again when it reaches 3/16 in., and after it reaches a predetermined limit, the piston is rebanded and the procedure is repeated. The piston is rebanded a maximum of three times.

. . . Nondestructive testing. This is used by 40% of the crude-oil lines and only a few of the products lines. Predominant techniques are magna flux, first, and X-ray, second. Dye-penetrant inspection, ultrasonics, and some visual inspection by chalk-and-alcohol are also cited.

. . . Teflon chevron rings in injection valves to solve injection-valve packing problems. Results are longer wear, less valve sticking, no leakage, no blown packing, none of the troubles common to ordinary packing.

Leasing pumping machinery . . . The leasing of pumping machinery is a new approach to the maintenance problem. For the first time in the industry, according to the user, two engines at a crude-oil pump station have been leased from the manufacturer.

The pipeline company got bids from three manufacturers. It leased the engines for 7½ years, after which it holds an option to buy. The pipeline reasons that the arrangement will keep the manufacturer keenly interested in helping to maintain the engines in peak working order.

ULTRASONIC measurement of pipe thickness and the detection of laminations where a hot tap is to be made are ways in which this instrument has aided maintenance.

MAINTENANCE REPORT

Sta. or Terminal No. _____ Location _____

Month of: _____, 19____

MOTORS & GENERATORS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MONTHS: MEGGER READING; GROUND; ELECT. CONNEX; INSUL. OIL LEVEL; COMMUTATORS & BRUSHES; BATTERY	12 MONTHS: VOLTAGE; AMPERAGE; DIELECTRIC STR. INSULATING OIL; BEARINGS; AIR GAP: TOP, BOTTOM, RIGHT, LEFT

MOTOR CONTROLLERS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	6 MONTHS: GROUND; ELECT. CONNEX; CIRCUIT BRKR. OIL; CONTACTS; DISCONNECTS; CIRCUIT BRKR.; FUSES; COILS; RELAYS; O'LOAD DEVICES; CLOS. MECH.; CONTROL DEVICES

TRANSFORMERS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MONTHS: TEMPERATURE; INSUL. OIL LEVEL; GROUND; INSULATORS & BUSHINGS	24 MONTHS: AMPERES; MEGGER READING; ELECT. CONNEX; DIELECTRIC STR. INSULATING OIL; MOISTURE; COILS; TAP CHANGER; FUSES & DISCONNECTS: RATING, CONDITION

BOILER & FURNACE CONTROLS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	6 MONTHS: GROUND; ELECT. CONNEX; RELAYS; THERMOSTAT; PRESS. SWT.; IGN. TRANS.; ELECTRODES; PROTECTO CUT OFF; VISAFLAME; COILS; CUT OFF DEVS. RELAYS & MOTORS; INSULATORS & BUSHINGS; CONTROL DEVICES

CABLES	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	24 MO.: ELECT. CONNEX; MEGGER READ.	ELECTRIC GAUGES	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MO.: INDICATORS; TRANSMITTERS	24 MO.: INSULATING OIL; MOISTURE	ELECTRIC STATION SWITCHGEAR	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MONTHS: GROUND; ELECT. CONNEX; CLOS. MECH.; CONTACTS; CIRCUIT BRKR. OIL; RECTOR UNIT; O'LOAD DEVICES; MEGGER READ.; BREAK MECH.

ALARM SYSTEMS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MONTHS: GROUND; ELECT. CONNEX; RELAYS; THERMOSTAT; PRESS. SWT.; BOILERS & SIG. LIGHTS; BATTERY; CONTROL DEVICE	ELECTRONIC CONTROLS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MONTHS: MEGGER READ.; GROUND; ELECT. CONNEX; RELAYS	LIGHTING FIXTURES & RECEPTACLES	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	6 MO.: GROUND; ELECT. CONNEX; FIXT. CONDITION

ELECTRIC HEATERS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	6 MONTHS: ELECT. CONNEX; CIRCUIT BRKRS.; CONTACTS; RELAYS; THERMOSTAT; HEATING ELEM.; CONTROL DEVICE	LIGHTING PANELS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MONTHS: VOLTAGE; GROUND; ELECT. CONNEX; Fuses & Discon'ctrs: RATING, CONDITION; CIRCUIT BRKRS.	REMARKS:

PYROMETERS & POTENTIOMETERS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	2 MONTHS: ELECT. CONNEX; CONTACTS; BATTERY; THERMOC'PLS; INDICATORS; RESISTORS	12 MO.: SLIDE WIRE & OIL	C. F. R. UNITS	DATE	SERVICE OR LOCATION	SERIAL OR UNIT NO.	6 MONTHS: GROUND; ELECT. CONNEX; HEATING ELEM.; CONTROL DEVICE	Signed: _____ Title: _____

ELECTRICAL INSPECTION sheet shows procedure for thorough electrical maintenance at stations and terminals.

Electrical maintenance . . . On electrical maintenance, a wide range of practices was reported. There were extremes of policies which called for little more than correction of failures on one hand and quite thorough inspection and preventive maintenance on the other.

Manufacturers state that the service of electrical equipment usually depends on the user's adherence to the cardinal rules: keep it clean, keep it tight, keep it friction free, keep it dry.

A regular program of inspection and maintenance to carry out these principles is represented by the chart shown above for motors and generators, cables, alarm systems, electric heaters, pyrometers and potentiometers, electric gages, lighting panels, electronic controls, motor controllers, switchgear, and other apparatus found at stations and terminals.

One company reports that the basis for all its maintenance on electric motors is keeping up the insulation, which is achieved by regular Megger readings to guard against a burnout.

The same is true of cables. Cali-

LIMIT SWITCH is set to control opening of motor-operated valve.

bration of settings on the time-delay relay, station pressure switch, sequence timing, and thermo switches are checked regularly by some companies, not by others, according to the survey.

For cleaning motors and stator windings, a major pipeline has been successful in using crushed corn cobs run through a sand blaster. This method avoids abrasion and perforation of insulation. Other methods for such cleaning are wiping, removing dirt by suction or blowing with compressed air, or cleaning with a petroleum solvent.

PISTON is pulled to replace rings during overhaul of a reciprocating compressor engine.

Some companies report that the reputation for reliability of electric stations is often an invitation for neglect of maintenance. As an example of the mechanical reliability of electric stations, a company which built one of the first outdoor stations reports that there has been no occasion to go into the units in 5 years except to change out centrifugal-pump impellers to meet different throughput requirements.

Oil lines report that remote-control systems have caused little trouble; their problem, they say, is in encouraging the common carrier to keep its loop in shape.

Compressor stations . . . Most natural-gas pipeline companies indicate that station equipment is overhauled at regular intervals. Some 20% of the companies, guided by the need for all available horsepower for winter peak loads, make annual overhauls. The remainder operate with a preventive-maintenance program until replacements are needed. Units may be overhauled every 2 or 3 years. One large transmission company follows a preventive-maintenance program without any set program for overhauls.

Some overhaul intervals are based on horsepower hours operated, as is the case with some oil lines. In other cases the extent of overhaul depends on the data obtained in daily, weekly, and monthly preventive-maintenance checks.

One company which schedules major overhauls on a 2-year basis has minor inspection during years between overhauls. Some of its reciprocating compressor units are run more than 2 years if engine hours and mechanical conditions warrant this decision.

Nondestructive testing is practiced by 90% of the natural-gas lines, magna flux being the leading method followed by X-ray, dye-penetrant inspection, ultrasonics, and visual inspection by chalk and alcohol. The temperature method of taking centrifugal-compressor efficiency has been tried experimentally to some extent.

Compressor-station advances . . . Several design advances in recent years have reduced maintenance. Some of these regarded by transmission companies as being important are full-flow oil filtration, aluminum and micro babbitt bearings, pressure lubrication, turbocharging to improve scavenging (to minimize maintenance on some types of older horizontal and vertical engines), and air-cooled heat exchangers for engine cooling.

Noteworthy equipment to facilitate compressor-station maintenance and overhaul include power tools and hoists to cut man-hours required for work and shorten down time of compressor units. Such simple steps as installation of parts racks and tool racks at strategic locations within reach have improved speed and thoroughness of maintenance and overhaul.

Synthetic lube oil for starting-air compressors and gas turbines is a very recent advance of maintenance significance. This fire-resistant lubricant is designed to prevent explosions in starting-air lines such as have plagued some operations. (See article starting on page 184.)

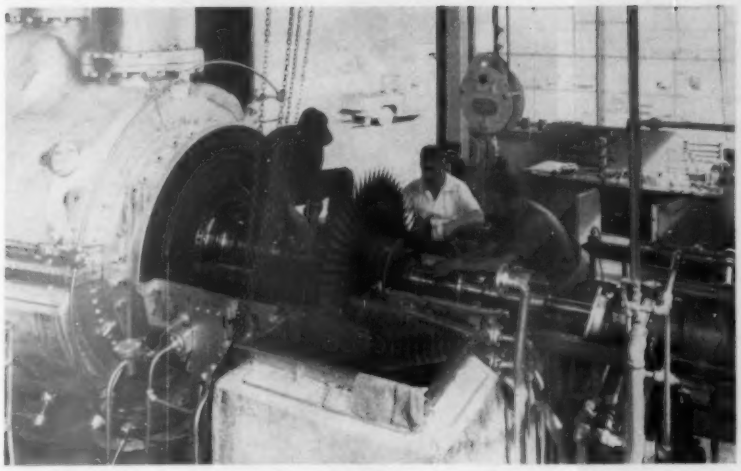
The synthetic lube oil has been successfully applied for the first time to a large gas turbine (13,400 hp.) at a remotely controlled compressor station. It adds considerably to the reliability of the satellite station and is considered a major advance in the company's automation program.

Engine analyzers . . . Three new instruments for engine analysis and balancing promise to reduce maintenance of compressor equipment. They are the pi-meter, Sperry engine analyzer, and Heath Kit selector switch.

The Sperry engine analyzer gives peak pressure by sine wave shown on a screen with engine-speed indication. It assists in the timing of an engine and serves as a vibration analyzer. The Heath Kit selector switch is an electronic device. A selector switch to each engine gets an indication of the firing of the cylinder. This is a form of ignition analyzer.

The pi-meter, a German-made power-cylinder indicator, is being tested experimentally at compressor stations. It indicates cylinder load (mean effective pressure). This recently developed instrument is being used to balance a gas engine. (See article starting on page 182.) Its purpose is to regulate all cylinders of a multicylinder engine to a mean specified pressure, to attain uniform loading for maximum efficiency, reliable operation, low maintenance, and long working life.

The ratio, P_Z:P_H (pressure per unit time/pressure per stroke), is determined for each engine type from characteristic graphs. The P_H values representing average values are given in a table. The scale is calibrated for a spring with pretensioning plate for time-average pressure of 2.6 to 5.2 kg. cm. If the pretensioning plate is removed, the instrument will indicate



GAS-TURBINE shaft and row of turbine blades are inspected regularly at compressor station to spot budding trouble and prevent breakdowns.

pressures between 0 and 2.6 kg./cm².

The instrument has no upper speed limit. It is therefore particularly suitable for regulating and checking high-speed engines. To check slow-speed engines (below 300 r.p.m.), a little thick engine oil is poured into the flywheel mass to secure steady pointer indication.

The effect of inertia results in the formation of a mean value referred to time (P_Z). To calculate the indicated output, the mean pressure, pi, related to piston travel, is used in all piston machinery. There is a relationship between these two pressures that is of a straight-line characteristic in most cases.

The ratio P_Z:P_H is represented by characteristic curves. The curve is established from indicator diagrams recorded at various loads. The mean time-average pressure is sufficient to regulate several cylinders to provide uniform output.

The gas pressure acts through a piston and rod complete with lever-and-pinion transmission system, with a large transmission ratio on a flywheel located in the rear of the instrument. The effective mass of the flywheel, derived from the square of the transmission ratio, receives the pressure fluctuations acting on the piston so that this takes up a position corresponding to mean pressure.

This position is maintained in equilibrium by an easily interchangeable spring similar to the indicator spring and located in a relatively cool position opposite the cylinder. Low natural frequencies are achieved by connecting an additional mass elastically with the main mass. The pointer of the instrument is mounted on the shaft of this additional mass.

2. Pipelines

THERE ARE numerous new techniques which are entering the picture of preventive maintenance on pipelines. These include internal coating, industrial television to go inside the pipe, internal pressure surveys, chemical cleaning, and new methods and equipment for the right-of-way.

Internal coating of gas lines . . . The internal coating of gas lines, which has been on an experimental basis in recent years, is the fastest-developing trend in the industry. It has come quite suddenly. A year ago the gas line which practiced internal coating to any great extent was a notable exception. This year the Journal survey disclosed that 40% of the gas lines are coating substantial mileage of pipe internally.

The sudden switch must be attributed to the pioneering work done by Transcontinental in coating more than 1,000 miles of 30 and 36-in. and the work of industry associations. Transco reported sizable increases in efficiency (about 5%) and reduction in pigging costs (OGJ, April 6, p. 107).

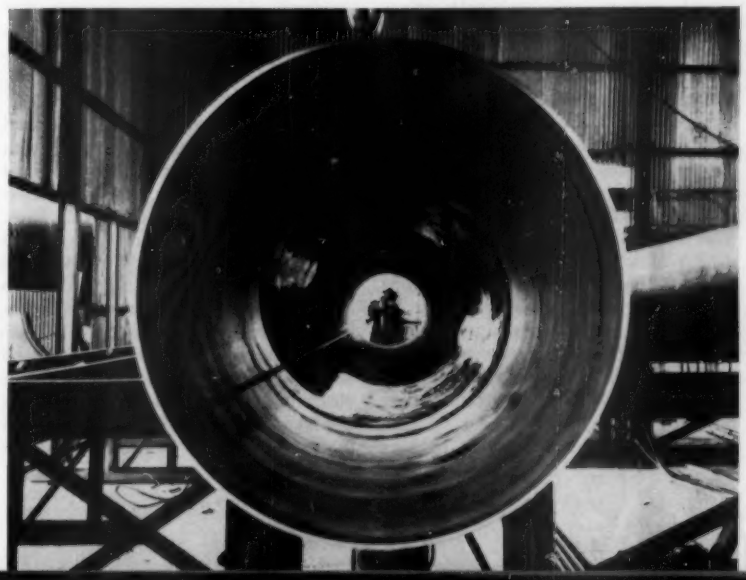
An industry test conducted this year came to similar conclusions—that efficiency is increased about 4% by internal cleaning, and an additional 1 to 6% by interior coating, depending on flow velocity (OGJ, June 1, p. 108). The influence of these tests on the industry has been profound.

Since the results of these tests were published, more than a thousand miles of large-diameter pipe has been internally coated. One new 30-in. line is being coated in its entirety. Several companies are internally coating a large portion of their loops laid this summer. The practice is expected to spread until it soon becomes the rule rather than the exception as it was just a year ago.

Two coating methods are employed to apply a thin film, usually of an epoxy material: yard coating, and in-place coating after laying. Most coating is done by the yard method before laying. However, some pipelines invite bids by both methods; one will accept either method, leaving the option to the contractor.

Internal coating of oil lines . . . Internal coating of crude-oil and products lines is practiced to a very limited extent. It has been successful in preventing internal corrosion on some sour-crude gathering lines in Oklahoma, Kansas, West Texas, and New

INTERNAL COATING of gas lines to reduce maintenance and increase efficiency is the fastest-developing new trend in the transmission industry.



PIG IS LAUNCHED in gas line to clean out rust, scale, and liquids. Scraper traps are being installed on an increasing number of gas trunk lines.

BEVELING MACHINE is set on a gas line without scraper traps so that a section can be cut out for pigging.

Mexico. It has also been applied to reduce paraffin deposition. Some precoolers on diesel engines are internally coated.

Products-line operators have shown little interest in internal coating, except for avgas and jet-fuel lines and in LPG-natural gasoline lines where inhibitors have failed to stop internal corrosion.

The effect of a slick plastic interior on flow efficiency of oil trunk lines is not known. Crude trunk lines have no major internal corrosion problem. Products lines find inhibitors or dehydration to be the most economical means of internal-corrosion control.

Only a few lines dehydrate, but they are strong for it on the grounds it is effective and the expense is justified. It is particularly suited to a closed system with a single input point. One company reports that it has used dehydration on a line for several years, and it has been kept sufficiently dry that inhibitors have not been needed. The mill scale is still on the line. Another company has abandoned dehydration.

Pigging practices . . . The advent of internal coating presents a problem in design of scrapers that will not damage the coating. New "tiptoe" scrapers which will provide a lighter brushing effect are undergoing development and testing. Internal coating also will reduce the frequency of running scrapers; just how much remains to be seen.

There is a great variety of policies in the frequency and basis for running scrapers. The survey showed that scraper runs are planned on a calendar schedule by 35% of the crude-oil lines, 60% of the products lines, and 33% of the natural-gas lines.

SCRAPER IS DUNKED in vat of boiling water to remove paraffin after running through an oil line.

Increase in pressure drop, as would be expected, is a major factor in timing of scraper runs for all types of lines. Increased stream contamination is a factor on 7% of the crude lines, 40% of the products lines, and 60% of the natural-gas lines. Consideration of line temperature and types of crude also are cited as important in scheduling scraper runs.

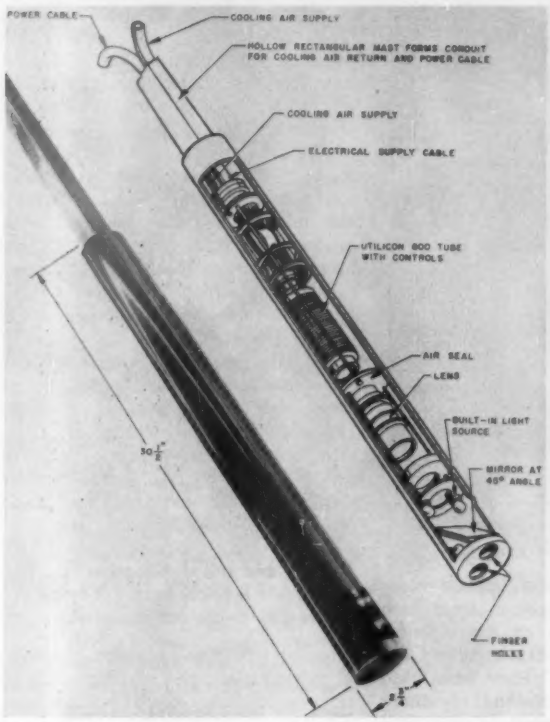
Line-cleaning operations have been facilitated by scraper detectors, self-cleaning strainers, and scraper cleaners located at scraper traps. An automatic pig passer developed by one operating company has enabled the company to run scrapers without the need to shut down stations. This has been the means of avoiding severe surges encountered during startup which could cause line breaks.

Scraper traps are being used to an increasing extent on the trunk lines of most of the natural-gas systems. Though scraper traps on gathering lines are increasing also, they are used by less than half the companies which have them on gas trunk lines.

Chemical cleaning . . . Chemical cleaning has proved its economic merits in extensive reconditioning and cleaning of old lines, particularly in converting from crude oil to products service. Within the past year chemical cleaning has been applied also to a new 12-in. products line for preventive maintenance.

This company is convinced that initial removal of mill scale from new pipe is an economic practice. It will result in a much cleaner line. Strainers will not often get clogged. Wear of pumping machinery and meters will be reduced, as will down time and storage-tank buildup. Several companies which have not tried chemical cleaning of new pipe for products lines expressed interest in its possibilities.

Television inspection . . . Inspection of welds by a television camera may be a coming development. A 2¾-in. TV camera has been designed to check welds inside of a 3-in.-diameter reac-



TELEVISION is newest device for inspection of welds, pipe condition, and coating inside the pipe.

HELICOPTER is used instead of light planes by some companies for line patrol in mountains or to carry emergency repair crews.

tor tube, and could have broader applications, such as internal-coating inspection.

The camera mounts on a handle of rectangular tubing which is the means of moving and rotating the camera inside of the pipe. A tube inside the handle supplies cooling air to the camera. The handle also carries the camera power cable and forms a duct for exhausting cooling air. A 17-in. television monitor and camera-control unit complete the TV inspection system. The two units are mounted on a cart for easy moving to an inspection site. The enlargement of defects on the screen permits a quick and accurate analysis of pipe condition.

Internal pressure surveys with instrumented pigs are an experimental development which bears watching. Internal surveys of various types, now in their infancy, may have wide applications of both design and maintenance significance. The possibilities are just beginning to be explored.

Ultrasonics are used extensively for various pipeline jobs. A dozen gas lines reported using an ultrasonic instrument to measure pipe thickness. It also aids in detecting laminations at points where a hot tap is to be made. It has proved to be valuable on compressor piping prior to upgrading a line and in preparing for hot tapping and for cutting in a valve setting. Several such instruments are in use at various locations on individual systems.

Another new ultrasonic instrument, called a pulse-echo flaw detector, has been designed for flaw detection in welds as well as for checking pumping machinery. The instrument works in this manner: Short-duration electrical pulses are generated. A transducer changes them to short acoustic or mechanical vibrations. The sonic pulse then propagates through the material and some energy is reflected from various boundaries such as the back of the part itself, shoulders, keyways, cracks, inclusions, porosity, and even grain structure under certain conditions.

The sonic echoes are picked up by the transducer and converted to electrical signals. These are amplified and displayed to indicate the presence, location, and characteristics of the internal reflectors.

Underground vs. aboveground piping . . . Pipeline engineers show their individuality in preferences for underground or aboveground piping at stations. Aboveground piping is preferred by 80% of the crude-oil lines in the survey and by all of the natural-gas lines. In sharp contrast some 70% of the products lines prefer underground piping.

Some products-line experience shows that the over-all costs of aboveground and underground piping are similar. The prospects for expense of continued painting of aboveground piping are said to weigh in favor of underground piping. One major products system puts piping aboveground only when required and underground wherever possible. In contrast, another large products system which has much of its station piping underground has, in recent years, placed more of it aboveground where practicable to avoid the effects of corrosion.

One crude-oil system has aboveground piping for large headers over 12-in. diameter. Smaller-diameter piping for headers is placed underground.

Helicopter patrol . . . Aerial patrol has virtually replaced the line walker or line rider for patrolling pipelines. However, ground patrol is still used to supplement aerial patrol, especially on old lines which do not have welded joints.

While light planes are standard for aerial patrol, the helicopter has performed this job in recent years to meet unusual conditions. The more expensive helicopter patrol has been used by two companies in the Appalachians because they consider planes ineffective in the choppy terrain of

HERBICIDES are proving to be money savers for controlling brush, weeds, and grass on the right-of-way, tank farms, and in station and pipe yards.

this region. The helicopter can follow the pipeline closely as it climbs hills and plunges down valleys. It is also able to transport maintenance personnel rapidly to repair a line break in the mountains.

Because of the ability to land to investigate trouble, helicopters also are considered for aerial patrol and other work for pipelines on the Gulf Coast. Attention is being given to development of a light welding generator, possibly made of aluminum, which could be carried by helicopter for emergency use. One of the unusual applications of the helicopter has been spraying for vegetation control on the right-of-way.

Herbicides . . . Herbicides have been used increasingly to save money in control of vegetation on the pipeline right-of-way, station grounds, and around gate settings, meter and regulator stations, pipe yards, and tank farms. Herbicides are deemed a must by some companies in the Gulf Coast and other areas of heavy rainfall which promotes lush growth of weeds and brush.

Some companies practice chemical spraying only in station yards and in tank farms. They prefer not to risk the damage claims which might result from killing adjacent crops, trees, or pasture.

Power companies and railroads, both big herbicide users, have found it is best to use competent bonded contractors for this specialized job. They report that proper chemicals and proper and careful application assure results and reduce risk of damages. Pipelines are expected to eventually follow the lead of these industries.

Herbicides have been applied mainly on weeds, and more in areas such as pipe yards than on the right-of-way. Their use for brush control has been quite limited. They have been effective for controlling hyacinth growth in swamp areas of the Gulf Coast and in preventing stumps from resprouting. Ground has been kept clear of post oaks and similar trees.

A varied selection of chemicals is available from four chemical companies for any type of treatment desired. They are applied generally from tractor-mounted units, by hand, or in swamp areas from marsh buggies. The particular chemical and method of application will depend on state regulations, the season, the type and condition of vegetation to be controlled, and selectivity desired.

A herbicide that will kill everything above the ground is often specified for tank farms, pipe yards, and similar installations. If selective killing is desired, a variety of materials and methods are available.

The first method used on brush was foliage treatment in spring or early summer. Brush and small trees also have been sprayed near their base during the dormant season. The most recent technique is to place herbicide pellets on the ground around the base of trees to be killed. Rainfall carries the chemical to the roots. The pellets take care of trees and brush without leaving the soil sterile. Trees are removed for good visibility in patrolling, but grass is left for erosion protection.

Experience has shown that specialists are required for effective vegetation control, and that the first year is not always completely effective. Pipelines must consider that chemicals may require three annual doses for brush control, although the first application may do the job. After a complete 3-year treatment, further applications would not be required for 5 to 7 years, according to some users.

Chemical control of brush has been shown to be possible without harm to forest trees. Recent chemicals are of low toxicity and can be used with safety near men and animals. But users emphasize the risk and uncertain results which are likely in the hands of inexperienced men.

As an alternative to herbicides, in a heavily wooded eastern region, maintenance crews of a products line clear right-of-way with a portable engine-driven brush cutter. In addition these maintenance crews are provided with a rotary-mower shredder that cuts a path 6 ft. wide. It is towed by a rubber-tired tractor.

Erosion and soil stabilization . . . Terracing and erosion dams are employed to prevent severe erosion of the right-of-way.

In midwestern farming areas, below-surface backfill repair is practiced by one company. The problem arises from settling of loose soil beneath the compacted backfill surface, leaving cavities which aren't visible on the surface. Some have swallowed up livestock and farm equipment. Mud fill pumped into the holes under pressure has been found to last much longer than the old method of dry-dirt backfill.

To assure a firm foundation around

BREAKS are problems on lines with old screw pipe.

WELDER REPAIRS leak on gas line with escaping gas lighted to prevent a possible explosion.

regulator stations, another company is experimenting with injection of a wood-pulp derivative into the soil. So far results are inconclusive, but the idea is considered to have merit.

Line-maintenance trends . . . More and bigger equipment along with fewer and higher-caliber men is one of two principal trends in line maintenance. The other is the increasing tendency to contract maintenance.

Some contracting of line maintenance is done by 80% of the crude-oil lines. Two crude lines reported they contract all of their line maintenance. Survey replies indicate that 85% of the products lines contract some line maintenance. All agree that it's generally cheaper. From the survey it appears that very little maintenance is contracted by natural-gas lines.

Organization of personnel to perform maintenance varies widely from company to company. There are extremes ranging from one major system which has several big gangs working full time to another which has no line-maintenance personnel whatsoever. Station personnel clamp off leaks as they occur and when several temporary repairs have been made, a contractor is hired to make all permanent repairs.

One new long crude system, well protected by a good coating and cathodic protection, has no maintenance gang. The only maintenance personnel as such are supervisors who will oversee contract crews if emergency maintenance arises. Another company is approaching this goal; it hires no new personnel. Eventually it will have only maintenance supervisors and the number of personnel required to do emergency maintenance and fill in as vacation relief at stations.

Mechanization . . . Mechanization of the maintenance gang has done more than anything else to reduce costs and speed repairs to minimize down time. Among the more important changes in recent years which were cited by pipeline companies are the introduction of the following equipment and tools:

. . . Small backhoe attachment for tractors.

. . . Rubber-tired heavy equipment with good mobility.

. . . Small power shovel mounted on a trailer and easily pulled by the maintenance truck.

. . . Trailers for welding machine that free the truck for other work.

. . . Portable light plants and pumps.

. . . Mobile radio.

. . . Pneumatic tools.

. . . Tapping machines.

Some companies have devised their own equipment such as trucks designed to hold tools and materials to make them convenient for repair work, and gin poles which extend over the side of a truck rather than the end for cradling pipe.

Gangs and equipment . . . One company which performs all of its own maintenance has several crews with a maximum number of eight in each crew. The company believes that eight is the largest number a foreman can supervise well. The crew includes a connection foreman, truck driver, welder, and five pipeliners. They go out on a job with Stopple equipment, a small tractor digger with backhoe attachment, and welding machine. If bigger equipment is required, it is leased from a contractor or supply house.

One company with some 2,000 miles of line has five maintenance gangs with an average of five per gang. Some gangs have two or three men, others seven or eight. The larger gangs have a gang foreman, an assistant, a truck driver, welder, and whatever pipeliners are needed. The company is strong for small gangs—a few men with plenty of know-how, as indicated by the fact that there is an

BACKHOE mounted on small tractor has become a "must" for many maintenance crews.

DITCHER is repaired during slack season in preparation for construction and maintenance work.

LEAK SPOUTS water at weak spot in products line being tested to upgrade for higher operating pressures.

assistant foreman. The reasoning is that a maintenance expert can always pick up a few hands to handle any job that arises.

A large system with several thousand miles of line recently consolidated separate crude and products crews in the same areas to cut costs. Centralized gangs can cover more territory and serve both systems. Gangs number 4 to 12, including a foreman, truck driver, welder, and 2 to 8 pipeliners. When a leak occurs, the foreman and two or three pipeliners stop it. A larger gang makes the permanent repair.

A crude system with some 15,000 miles of line has 48 crews, or one for each 300 miles. The system is composed of multiple parallel lines up to 24-in. diameter. Crews will repair from 1,500 to 1,700 leaks per year. Crews vary from 4 to 25, with an average of 13, about half of them skilled and half unskilled. A crew of 17, frequently used for big jobs, would include the connection foreman, truck driver, welder, operator for light tractor, assistant foreman, crew clerk, crew chauffeur, relief crew chauffeur, relief truck driver, welder-pipeliner, heavy-equipment operator, and 6 pipeliners. This crew would have the following equipment:

. . . Two heavy trucks with combination dump and utility bed.

. . . One half-ton pickup truck.

. . . One 10-man panel truck or nine-passenger station wagon.

. . . One three-quarter-ton truck equipped with 200-amp. arc-welding machine, acetylene-welding equipment, and tools.

. . . One tractor with sideboom and angle dozer.

. . . One half-yard dragline or medium-size ditching machine.

. . . One light tractor with backhoe.

. . . One equipment trailer.

. . . One pole trailer.

. . . One 200-amp. skid-mounted welding unit.

. . . One portable oil-pickup pump.

. . . One pipe-cleaning machine.

. . . One 105-cu. ft. or larger portable air compressor with pneumatic tools such as paving breakers, jack hammers, and pneumatic spades.

. . . Two 3-in. water pumps.

. . . One pipe-tapping machine.

. . . One pipe-cutting machine.

. . . One lineup clamp.

. . . One electric hand grinder.

. . . One portable electric generator and flood lights.

. . . Air wrenches.

. . . Safety equipment as required.

This equipment list represents what a large crew would have to maintain a large-diameter line. Slightly smaller crews would have only one piece of heavy equipment—either of D6-type tractor, a backhoe, or a ditcher. The heavy equipment is located at the district maintenance headquarters for assignment wherever needed.

Maintenance gangs of an eastern products line have found that a medium-weight crawler tractor fitted with hydraulic-actuated backhoe attachments and skid shovels has reduced maintenance costs. The units are easily transported on 10-ton tilt-type trailers pulled by a 14,000 to 18,000-lb. class tractor truck.

Several companies have been storing aluminum pipe fabricated into short bypass loops at strategic points on their pipelines. Placed at 50 to 80-mile intervals, the loops are valuable in emergencies for bypassing a line break to expedite repair. Connections are made by quick-acting couplings.

Leak detection . . . Leak detection is done in several ways. Leaks are usually spotted by aerial or ground patrol from such indications as dead vegetation, soil discoloration, oil slicks on ponds, odor, or flow or pressure discrepancies and changes if the leak is large.

Leak-detection instruments are being used increasingly. An infrared leak detector has been used successfully on natural-gas lines on the west and east coasts. Where foot patrol has failed to locate a leak on an oil line, an audio detector has been effective. The detector, having a range of 300

RECTIFIER is checked periodically for groundbed performance and efficiency of cathodic protection.

to 1,000 ft. for small leaks, is placed directly on the surface of the pipe which is operated at normal pressures. High-frequency vibrations are picked up, transmitted to another instrument and amplified so that they will be audible to an operator with earphone.

Corrosion protection . . . As in other phases of maintenance, different policies prevail in regard to protection applied to lines after repairs. If the line is coated, the coating is repaired after a patch or new section of pipe has been welded. If the line is bare, it may or may not be coated, depending on the practice of the company. Some companies coat repaired sections of unprotected bare line and install anodes as well, but many merely stop the leak without coating or applying cathodic protection.

Conventional cold-applied enamels are used for most repairs, but several companies report plans to use plastic tapes to a greater extent.

Line preventive maintenance . . . Most companies maintain their lines by repairing leaks as they occur. A few practice preventive maintenance of old lines based on pipe-to-soil and soil-resistivity surveys. Occasionally an entire line with frequent corrosion leaks will be taken up, reconditioned, and relaid. A 30-mile 8-in. line in West Texas was upgraded in this manner last year.

Water-pressure testing of old lines is favored by most of the natural-gas and crude-oil pipeline companies. Some heartily recommend it wherever possible. It was disapproved in only 13% of the natural-gas questionnaires and in 20% of those received from crude lines. But refined-products lines replying in the survey were divided evenly on the issue. One products line with several thousand miles of old pipe has pressure tested old uncoated pipe as a general policy of preventive maintenance. The program has netted appreciable savings, the company states, and old low-pressure lines have been upgraded to modern high-pressure service.

Good results are reported for the use of iron-powder electrodes in repairing high-yield pipe. (See article starting on page 171.)

Marine maintenance . . . Various new methods have been found for repairing marine lines.

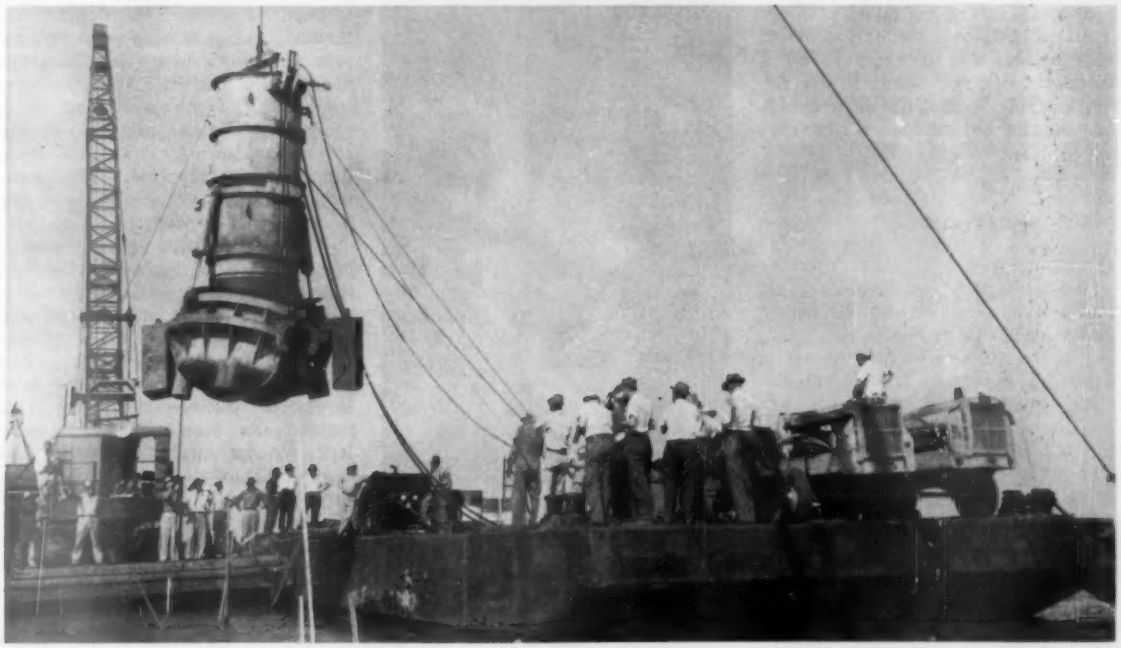
Replacement of a Delaware River crossing at considerable cost was avoided by a products line by pulling an 8-in. line through a damaged 12-in. line which had been in service. The pull through the 12-in. was 6,300 ft. across a river channel with a maximum depth of 49 ft. mean low tide. The damaged section of line had been buried in silt below the channel floor at a minimum depth of 56 ft. The cost proved to be only a fraction of that for laying a new line. This was believed to be the first example of such a repair.

A caisson for inspecting, tapping, and repairing submerged lines up to 20-in. in diameter in marsh areas and inland waters has been developed and tested by an oil pipeline on the Gulf Coast. The company will rent and license the caisson to other pipelines. The caisson has a jaw at the bottom with provision for snugly fitting the pipe. The jaw opening is 70 in. The caisson can be used in water depths up to 50 ft.

Divers are available for regular inspection as a means of preventive maintenance for submerged lines. They will walk lines on the floor of streams and lakes to check condition of the pipe and ditch so that a situation which might lead to a break may be found and corrected.

One transmission company installs heavy zinc bracelets on its lines in the Gulf of Mexico and South Louisiana marsh to provide cathodic protection for up to 60 years. Considerable safety factor is desired because of the high cost of repairs.

CAISSON for underwater repair, being lowered onto submerged line, is an important advance in maintenance.



SANDBLASTING of oil-tank roofs while in service has proved safe by bonding tank, equipment, and operator to prevent static-electricity buildup.

3. Storage tanks

NEW METHODS of cleaning tank surfaces, inside and outside, and new patching materials, for both inside and outside, and new coating materials are improving tank maintenance.

Sandblasting in service . . . Sandblasting of oil-tank roofs while they are in service is a new technique which saves time and money. The safety of the method was determined recently in several tests. The operation has long been considered a fire hazard. But the tests proved it to be safe, provided proper precautions are taken.

Static electricity, the only problem encountered, was overcome by a thorough bonding system. In dry air, buildup may be as much as thousands of volts on equipment or structures which are insulated from the ground. The tank, equipment, and sandblasting operator were bonded to prevent buildup of static electricity. Steps also were taken to control the escape of flammable vapors.

While sandblasting creates sparks, they are cool sparks which are further cooled somewhat by blasting air. These sparks aren't hot enough to ignite hydrocarbon vapors. The abrasive action of sand on tank steel also generates heat, also reduced by blasting air, and again the heat is not sufficient to ignite vapors.

Painting and leak repair . . . Policies on protecting tank exteriors vary from "painting when we get around to it" and spot painting as needed to regular painting every 3 to 5 years, depending on the area. The latter policy is justified by its public-relations value as well as its value in preventive maintenance. It is in sharp contrast to the practice, existing several years ago, of painting only the lower 5 ft. of the shell which was subject to severe corrosion.

The epoxy family of coatings, although twice as expensive as ordinary paints, is finding increasing use for severe service such as tank roofs where water stands in low places. While paint usually lasts only a short time under such circumstances, the epoxies applied in 15 to 20-mil thickness are giving several years' service. They are being used to a rather limited extent inside the tank as well, for the bottom, lower 3 ft. on the shell, and the vapor space.

PLASTIC PATCHING of tank exterior to seal leaks can cut maintenance costs.

Various plastics also are being used to patch leaks in tank bottoms and tank shells, particularly on riveted tanks which leak at the seams. Some companies prefer to sandblast or acid clean the tank completely before patching, then paint it afterwards. Others simply clean the surface in the area of the leak and apply the catalytic-setting plastic.

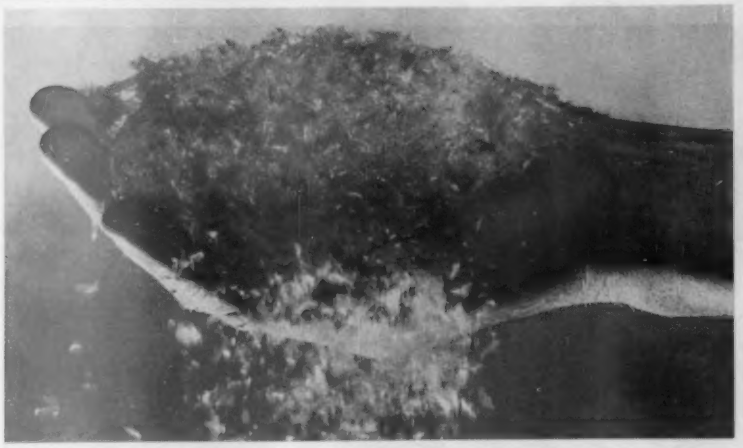
Plastic patching has been done successfully on a tank shell with 25 severe corrosion leaks. The leaks were sealed while the tank was in service under normal flow pressure from within the tank. This method worked after calking had failed. A long tear where the cone roof joins the shell of a tank was repaired by applying glass cloth laminated with plastic.

Still another new approach to exterior patching is the use of plastic glue (an epoxy adhesive) to affix a steel patch. Some companies also have stopped shell leaks by reaming out the leak hole, inserting a lead-sheathed bolt, and tightening the bolt, thus expanding the lead in the hole.

Plastics have been used in patching the bottom of a tank which was so severely corroded that a new tank bottom was planned. This tank was emptied of crude oil, chemically cleaned, and a thermal-setting plastic reinforced with glass cloth was applied to the bottom. All leaks were stopped. The job was done in a fourth of the time and at half the cost of replacement with new steel, the company reported. This technique has not yet been accepted throughout the industry.

Plastic flakes have been the answer in some cases to sealing hard-to-find leaks. Flakes ranging in size from a pin head to 2 in. in diameter are pumped into the tank in the general region of the suspected leak. They are drawn into leak holes and kept in place by differential pressure. This method has been reported to stop leaks without further trouble. It has been used to supplement the more prosaic use of bran and manure for stopping bottom leaks.

For severe corrosion in the b.s. and w. area on the shell, a complete new steel liner is sometimes welded to the



PLASTIC FLAKES are sucked into small leak holes in tanks, are held in place by differential pressure.

GUNITE COATING reinforced with wire is used in tank-bottom repair, especially when very light crudes are being stored.

shell as an alternative to spot welding and extensive patching.

Cleaning crude tanks . . . B.s. and w. continues to be a problem in crude-oil-storage tanks, but new methods are being introduced to cope with it. The widespread use of tank mixers—some companies now have them on all crude tanks—has contributed to the control of bottom buildup.

Solvent treating, an in-and-out bottoms-reclaiming method which has been around for years, has gained new favor in the past 2 years. Several companies have reclaimed bottoms by this method, which often results in a saving above the cost through recovery of good oil. Solvent treating is applied either while the tank is in service or after it has been shut down. Solvent is pumped into the tank under pressure to break up unpumpable bottoms. The contents of the tank are agitated and circulated, with the injection of more solvent, until most of the bottom can be pumped.

Another approach to solvent treating is planned by one company which has had trouble with stream contamination from chunks of b.s. and w. from tanks with 4,000 to 5,000 bbl. of bottom. Mixers will be installed in the tank, followed by injection of emulsion-breaking chemicals and wax solvents behind the mixers. This method depends on the agitation of the mixers alone without additional pumping pressure or means of breaking up the bottom.

While mechanical cleaning or heat treating, or a combination of the two, continues to be the principal means of cleaning crude-oil tanks, pipelines report they are attracted by the chemical approach because it is cheaper and safer. As a general rule, pipelines state that they do not clean a tank unless they are forced to go into it for repairs.

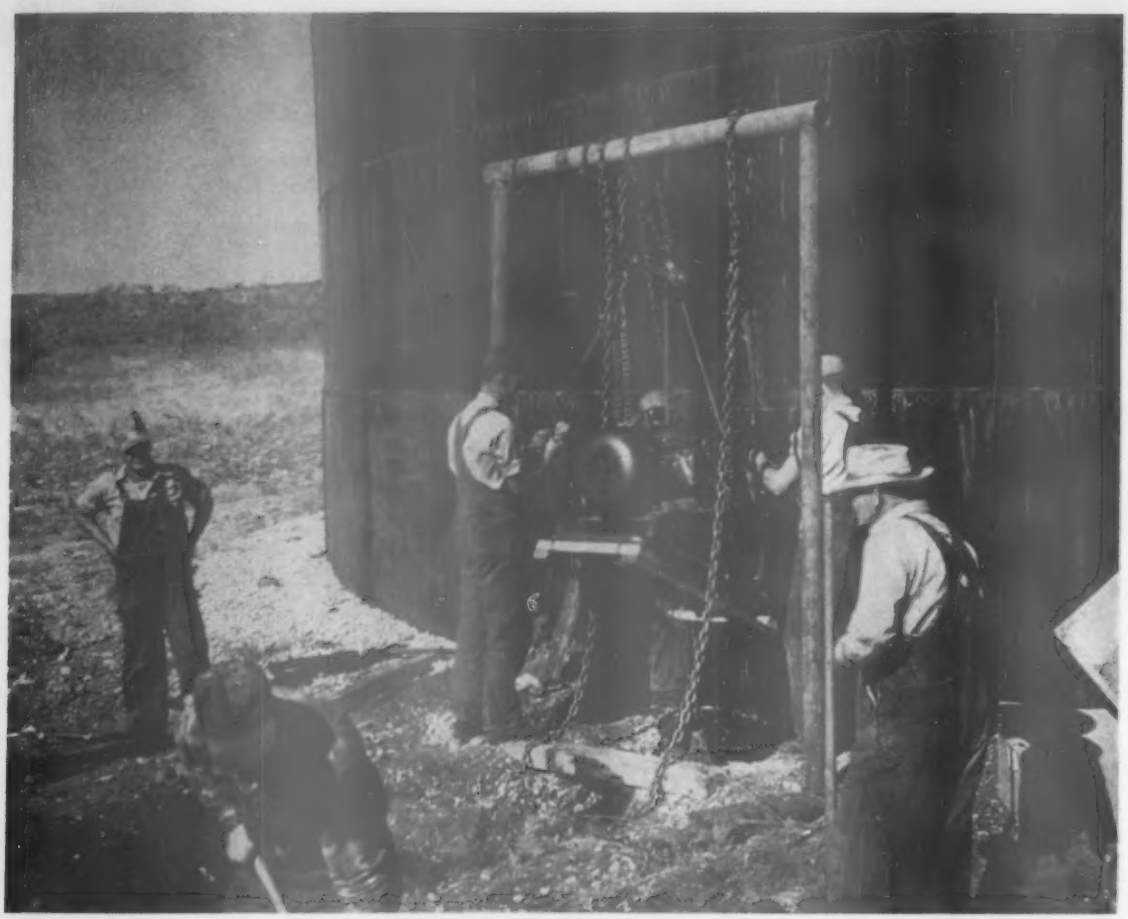
Tank-maintenance crews . . . Most companies have their own tank-maintenance crews which are supplemented by contract crews for b.s. and w. removal, painting, and major repair. Tank maintenance is handled by very small crews, with two or three men responsible for from 100 to several hundred tanks. Crews include a foreman, a welder, and a tank mechanic, if needed. For a large job line-maintenance crews are tapped for personnel.

One large products system with some 700 tanks is able to keep them in top shape with only three crews of three men each. This maintenance program includes a routine of welding the seams of old riveted tanks, regular outside painting every 5 to 10 years, depending on the area, and interior cleaning as required.

Contractors are often called upon to install cathodic protection for external corrosion of the bottom. Company policies differ greatly. Some apply cathodic protection with anodes or rectifiers, especially on old tanks which rest on mud or dirt. If a tank is on a well-drained grade with crushed-rock pad and concrete ring wall, cathodic protection as a rule is not applied. Although some corrosion occurs in such circumstances, it isn't certain that cathodic protection is the answer.

Cleaning products tanks . . . Products tanks, which are protected from internal corrosion by inhibitors, are

TANK VENT VALVE inspection and maintenance is performed regularly.



MIXER being installed on crude tank has helped to solve the problem of excessive b.s. and w. buildup, one of the biggest headaches with crude storage.

cleaned for one of two reasons—to change from one product to another, or to permit repairs.

Each company seems to have developed its own methods or modified existing ones, and the same is true of equipment. The approach of one operator which has been very effective will be described.

Since tank cleaning can be very hazardous, extreme care is taken. Precautions begin with the apparel of the worker. After the tank has been emptied of all but a few puddles on the uneven floor, the worker enters clad in white coveralls and cap, white socks and underwear, rubber gloves, rubber boots, and a face mask which is supplied with fresh air from a blower outside the tank.

He is thus protected from vapors and dangerous tetraethyl-lead deposits. The all-white garb is selected to show quickly and clearly when a dangerous amount of sludge has collected on his clothing. The purpose is to guard against absorption of lead from deposits in the dirt and sludge on the tank floor. When the clothing becomes dirty, it is changed. It is always changed at least once daily.

The worker, armed with a high-pressure water hose, flushes sludge from the floor into a water sump hole. From there it is pumped outside into a pit dug especially for the purpose. The pit is covered after the job has been completed because of the presence of lead. While cleaning is under way, at least two men remain outside to check the operation and assure proper functioning of the equipment. Spare masks are available for emergency rescue work.

If repairs are to be made inside the tank, it must be cleared of all vapors. Manhole covers are removed to permit air circulation. To speed vapor removal, this company has found an exhaust fan with an explosionproof motor placed over a manhole works well. Before repairmen enter the tank, a vapor check is made with a combustible-gas detector. A representative of a tetraethyl-lead firm also confirms that the tank is lead free. Then it is safe for workmen, unprotected by face masks, to enter with welding tools and commence repairs.

If the structure is a floating-roof tank, the roof must be suspended at a level which will provide working space. A new type of adjustable support is used for this job. The supports have in some cases replaced the old type of hanger.

A special trailer has been designed and built for tank cleaning. It contains all the equipment required for the job. This includes a power blower, diaphragm sludge pump, special clothing, high-pressure water pump and 150 gal. of water for flushing out the tank bottom. Inclusion of the water supply in this compact trailer made it possible to avoid laying water lines to a tank to be cleaned.

repeat business . . . **3 MAJOR EXPANSIONS AWARDED TO BROWN & ROOT** *in eleven years*

In 1946, and again in 1955 and 1957, Brown & Root was called in for construction of the constantly-growing plant of Southland Paper Mills, Inc., at Lufkin, Texas. This concrete evidence of customer satisfaction is typical of Brown & Root's record through the years of doing the job right, in shorter time, at lower costs.

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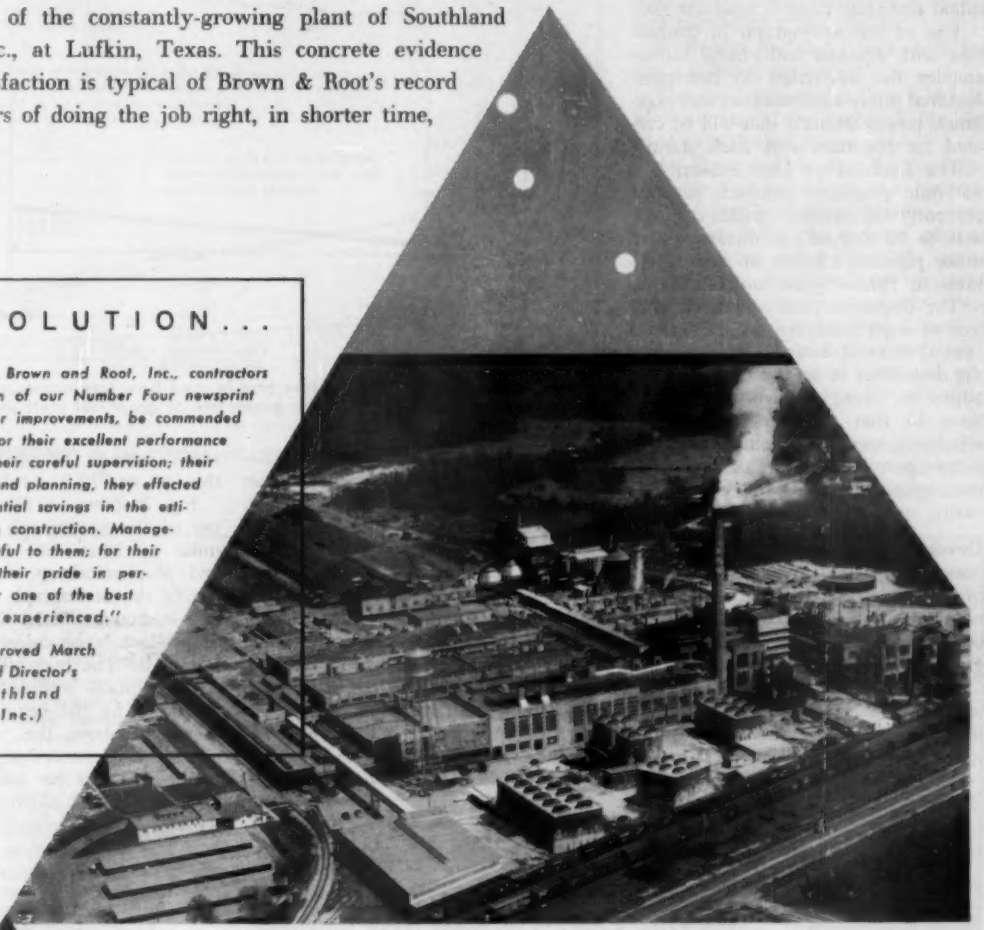
"RESOLVED, That Brown and Root, Inc., contractors for the installation of our Number Four newsprint machine and other improvements, be commended by Management for their excellent performance rendered us. By their careful supervision; their fine engineering and planning, they effected us a very substantial savings in the estimated cost of the construction. Management is very grateful to them; for their cooperation, for their pride in performance, and for one of the best jobs we have experienced."

(Unanimously approved March 31, 1959 at annual Director's Meeting of Southland Paper Mills, Inc.)



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Shortcut to Pump selection for least power consumption

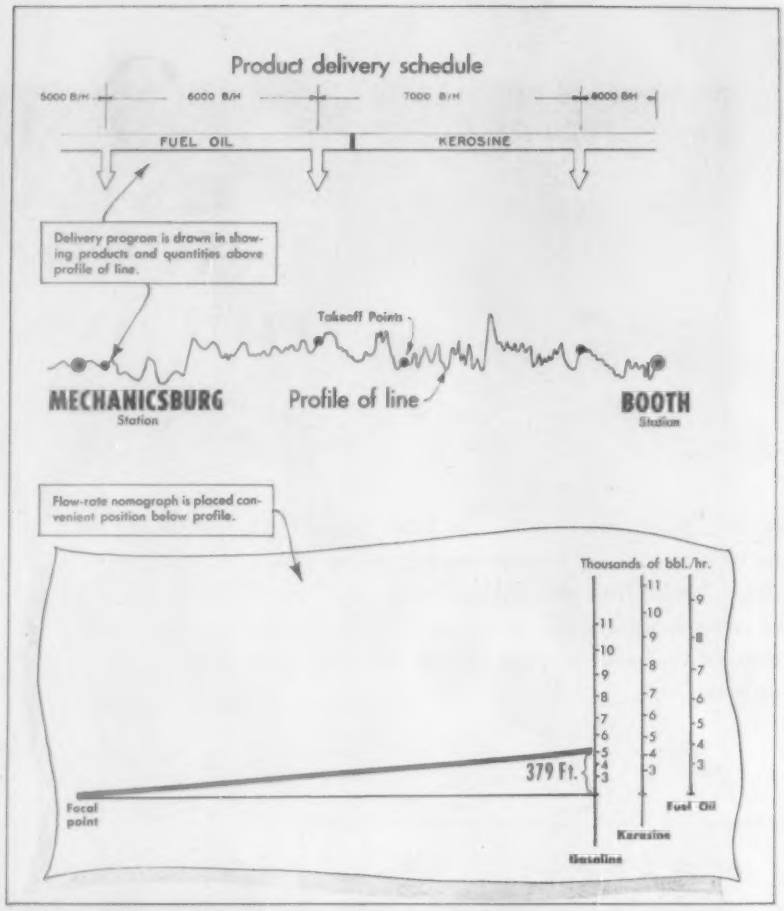
...when shipper's terminal demands vary along route

THE HYDRAULIC NOMOGRAPH is a simplified method for determining the optimum selection of pumping units to fit the hydraulic conditions resulting from varying shipper's terminal demands along a products line.

Use of the nomograph in connection with demand and charge curves enables the dispatcher to determine required pump combinations and maximum power demand that will be created for the month at each station.

The Laurel Pipe Line System is a 450-mile petroleum-products pipeline currently delivering 16 grades of products to 20 shipper's terminals and to other pipeline carriers at three locations in Pennsylvania and Ohio.

The dispatcher has automatic control of each metering station from a central control board. This enables the dispatcher to set the flow rate and adjust to changing hydraulic conditions so that maximum throughput efficiency can be obtained at minimum power costs. The hydraulic nomograph enables him to do this easily, quickly, and efficiently.



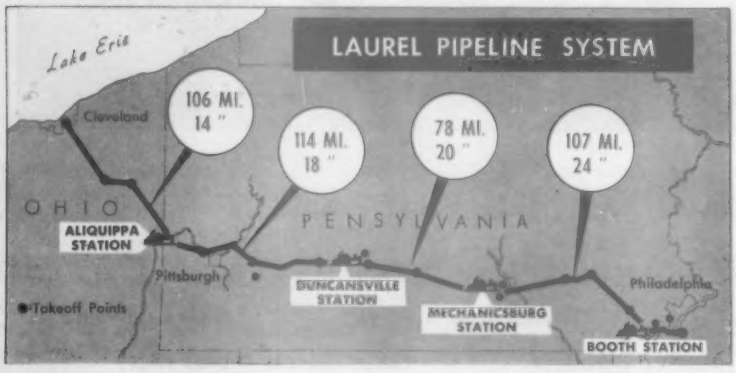
PRODUCT DELIVERY SCHEDULE, line profile, and flow-rate nomograph are placed in proper relation to each other to begin use of graphical method. Fig. 1.

Development . . . Figs. 1-3 show the basic theory used in the development of the nomograph. The flow-rate nomograph, lower section of Fig. 1, is used to determine the hydraulic-gradient slope for a given flow rate. Connect the focal point with the selected flow rate when pumping through the 24-in. line from Booth to Mechanicsburg stations. Vertical distance, as measured by vertical scale on pump characteristics curve (see Fig. 4) represents friction loss in feet of head.

This particular chart is plotted for 100-mile intervals for flow of gasoline, at a 105-mile interval for flow of kerosine, and at a 110-mile interval for flow of fuel oil. But the slope of the hydraulic gradient would be the same for any length. The friction loss in a 1-mile section is 3.79 ft. of head when pumping 5,000 bbl. per hour of gasoline. A 100-mile 24-in. pipeline would have a friction loss 100 times this loss, or 379 ft., as shown on Fig. 1

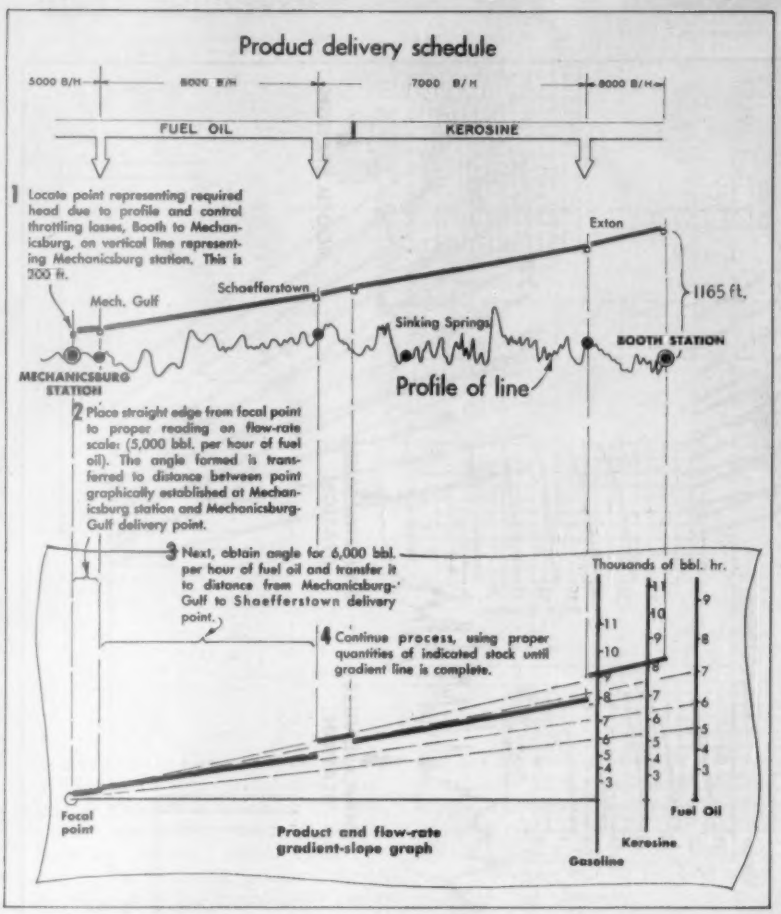
Fig. 2 shows an illustration of the use of the nomograph for the 107.3 miles of 24-in. line between Booth and Mechanicsburg stations. At the top of the nomograph a hypothetical case is shown with 1,000 bbl. per hour of product being delivered to various terminals. The hydraulic gradient for this condition would be constructed as shown by the heavy red line immediately above the profile. Beginning at Mechanicsburg station this gradient would be constructed thus:

1. Locate the starting point on the vertical line representing Mechanicsburg station. This must be at a height above the profile intersection equal to



BY MARLAN G. JORDAN

. . . chief engineer for Laurel Pipe Line Co. He joined Gulf Refining Co. in 1950, after graduating with a civil-engineering degree from Southern Methodist University. Jordan served with Gulf as laborer, design engineer, and transportation-department staff engineer. He advanced to his present position in 1958.


Product delivery schedule
5000 B/H
8000 B/H
7000 B/H
8000 B/H
FUEL OIL
KEROSINE
1 Locate point representing required head due to profile and control throttling losses, Booth to Mechanicsburg, on vertical line representing Mechanicsburg station. This is 300 ft.
Exton
Schaefferstown
Mech. Gulf
1165 ft.
Sinking Springs
BOOTH STATION
MECHANICSBURG STATION
Profile of line
2 Place straight edge from focal point to proper reading on flow-rate scale: (5,000 bbl. per hour of fuel oil). The angle formed is transferred to distance between point graphically established at Mechanicsburg station and Mechanicsburg-Gulf delivery point.
3 Next, obtain angle for 6,000 bbl. per hour of fuel oil and transfer it to distance from Mechanicsburg-Gulf to Shaefferstown delivery point.
4 Continue process, using proper quantities of indicated stock until gradient line is complete.
Thousands of bbl. hr.
Focal point
Product and flow-rate gradient-slope graph
Fuel Oil
Kerosine
Gasoline

SLOPES REPRESENTING HEAD LOSSES are transferred from nomograph to profile. Fig. 2.

the head the pump at Booth must put up to take care of elevation head requirements and control throttling losses.

2. For the 5,000-bbl. per hour flow of fuel oil between Mechanicsburg station and Mechanicsburg-Gulf metering station, place a straightedge through the focal point and the intersection of fuel oil flow of 5,000 bbl. per hour, and transfer this friction loss vertically and parallel as shown by the heavy red line for this section of line.

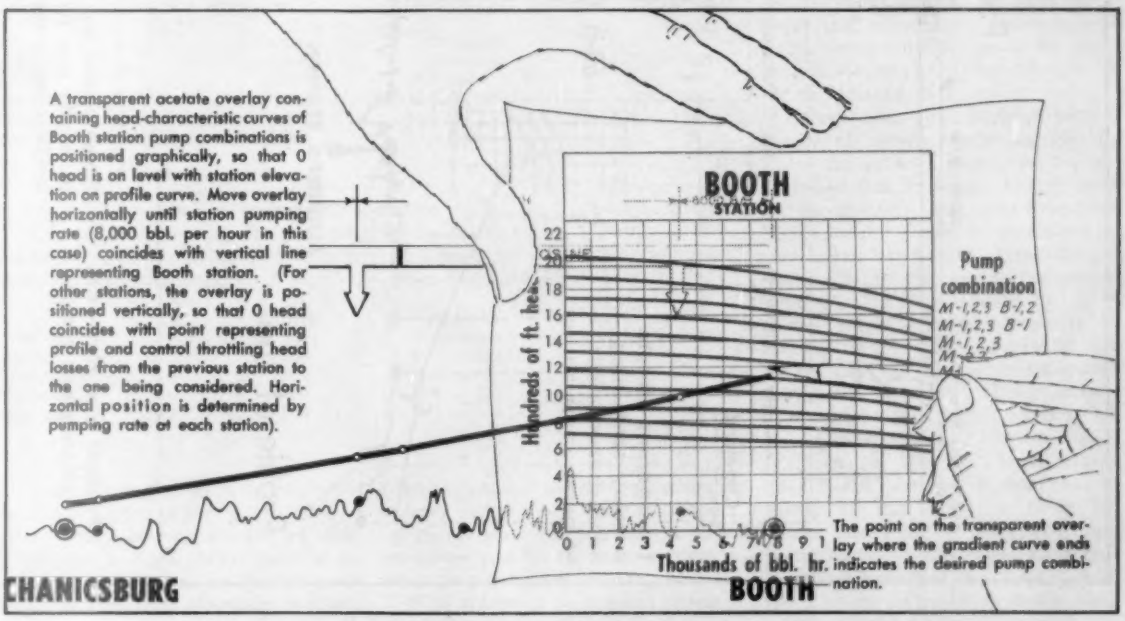
3. For the 6,000-bbl. per hour flow of fuel oil between Mechanicsburg-Gulf metering station and Schaefferstown metering station, place a straightedge through the focal point and a 6,000-bbl. per hour flow of fuel oil and transfer this friction loss vertically and parallel in a like manner.

4. Repeat the above procedure for the remaining sections.

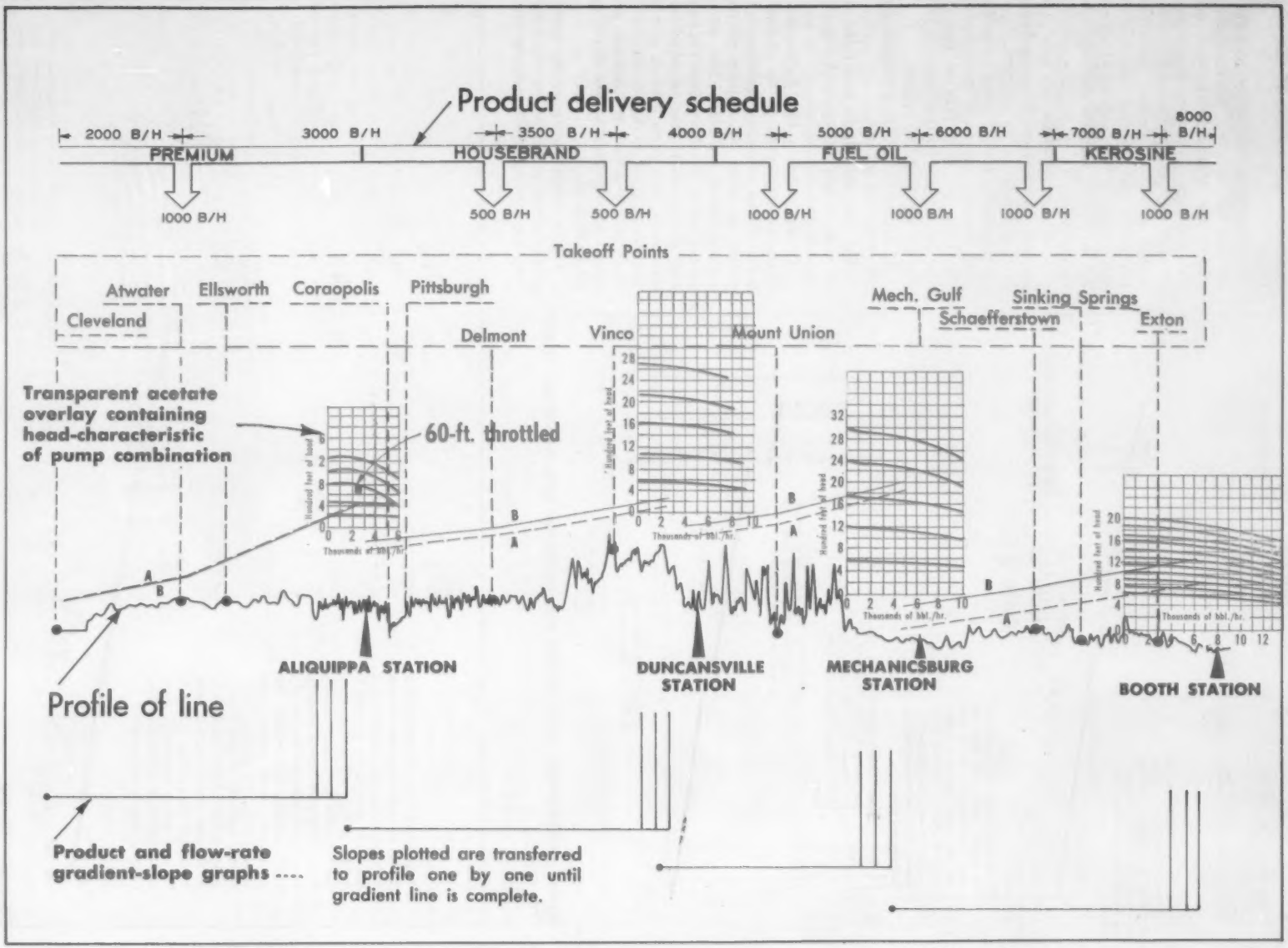
The final step shows that 1,165 ft. of head would be required for the hypothetical case shown.

As illustrated in Fig. 3, the head characteristic curves of the electric-motor-driven centrifugal pumps, connected in series, have been plotted against barrels per hour. This transparent curve has been superimposed over the hydraulic gradient which selects main line units Nos. 1 and 3 plus one booster to deliver the 1,165 ft. of head at a flow of 8,000 bbl. per hour with the control valve throttling 60 ft. of head.

Fig. 4 shows the hydraulic nomograph for the entire system, which has been constructed and is actually used


A transparent acetate overlay containing head-characteristic curves of Booth station pump combinations is positioned graphically, so that 0 head is on level with station elevation on profile curve. Move overlay horizontally until station pumping rate (8,000 bbl. per hour in this case) coincides with vertical line representing Booth station. (For other stations, the overlay is positioned vertically, so that 0 head coincides with point representing profile and control throttling head losses from the previous station to the one being considered. Horizontal position is determined by pumping rate at each station).
BOOTH STATION
Pump combination
M-1,2,3 B-1,2
M-1,2,3 B-1
M-1,2,3
Hundreds of ft. head
Thousands of bbl. hr.
The point on the transparent overlay where the gradient curve ends indicates the desired pump combination.
CHANICSBURG
BOOTH

TRANSPARENT CURVE is positioned to determine required pump combination. Fig. 3.



TWO TRIALS are made to determine combination of pumps at each station to give minimum throttling loss. Fig. 4.

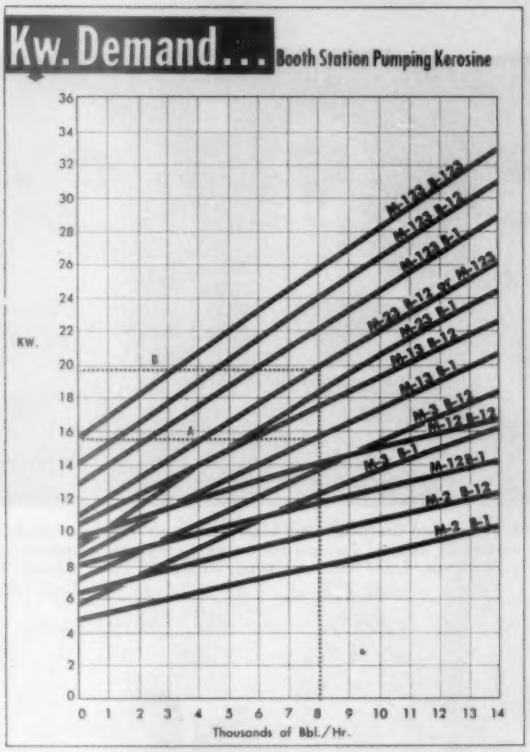


Fig. 5.

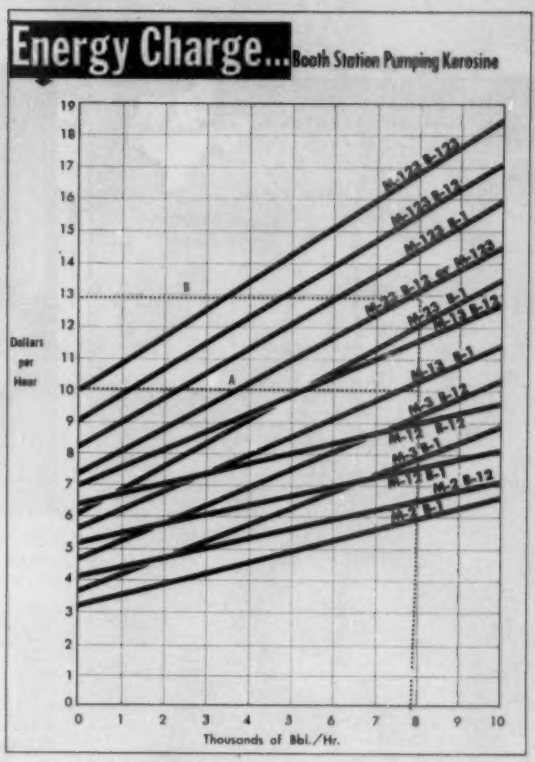


Fig. 6.

as illustrated in Figs. 1-3. Near the top of Fig. 4 is a hypothetical case showing the product as it lies in the line, with deliveries being made at various metering stations, which would result in the hydraulic gradient shown by the dashed line immediately above the profile. When attempting to adhere to this gradient by matching the incoming residual pressures with the zero point of the pump curves, the following results are obtained:

Station	Barrels per hour
Booth	8,000
Mechanicsburg	5,000
Duncansville	4,000
Aliquippa	3,000

The solid line on Fig. 4 shows the effects of incorporating the use of another pump combination which gives the following results:

Station	Barrels per hour
Booth	8,000
Mechanicsburg	5,000
Duncansville	4,000
Aliquippa	3,000

The throttling of 60 ft. at Alquippa station is shown in Fig. 4.

It should be pointed out at this point that it is not always possible to trade feet of head at Booth station in order to keep from throttling head at, for example, Aliquippa station. It may not be economical from a horsepower standpoint, to let Booth station supply additional head at a higher pumping rate and supply this head to a station with a much lower pumping rate. Therefore, one of the first steps in using the nomograph for a particular pump combination requires the selection of pumping equipment which will result in the lowest possible power cost.

Because of the many factors involved in moving products through the Laurel Pipe Line System, a graphical method for determining minimum power cost has been developed. Power costs depend on the kilowatt demand created and the actual kilowatt hours of energy used at each station. The minimum cost for the entire system is what we strive to determine.

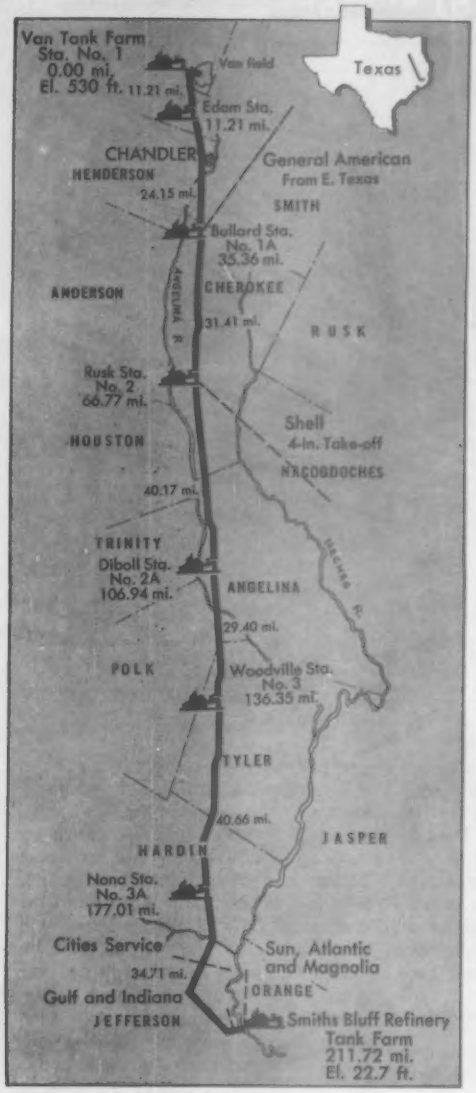
Pump-unn selection	Ft. of head throttled
M-1 and 3 + B-1	60
M-1, 2, and 3	360
M-2	440
M-1 + B-1	150
Total	1,010

Pump-unit selection	Ft. of head throttled
M-1, 2 and 3	0
M-2 and 3	0
M-1	0
M-1	60
Total	60

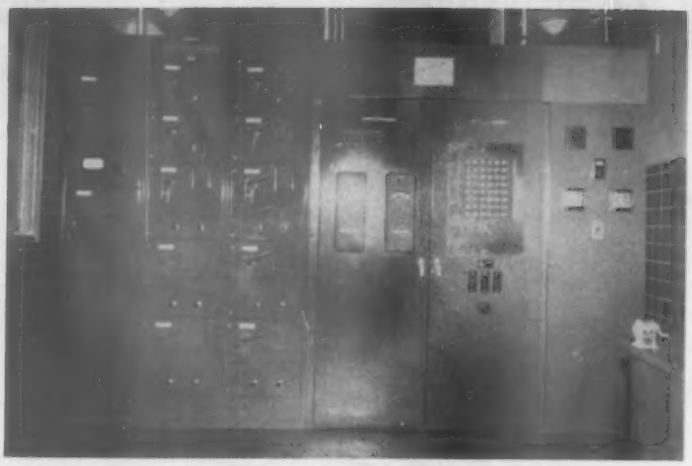
With reference to demand charges, curves have been plotted for the various pump combinations at each of the four pump stations when pumping gasoline, kerosine, or fuel oil. An example of these curves is shown by Fig. 5. Through the use of these curves, and the hydraulic nomograph, the dispatcher may determine the maximum kilowatt demand that will be created for the month at each pump station. If the kilowatt demand is excessive for the month at a particular pump station, he may then lower this demand by choosing different pump combinations or by altering the monthly pumping schedule to reduce demand charges.

Energy costs are calculated with a family of curves similar to Fig. 6. These curves were plotted on the assumption that additional energy used for the month at any one of the four pump stations would be purchased at the lowest cost per kilowatt-hour called for in the power company's contract. The cost shown by these curves would not be representative for the first part of the month, but would apply to the energy consumed during the latter part of the month. The cost for the pump combination shown by the dashed line on Fig. 4 (Path A) is $35 per hour, versus $31.25 for the pump combination shown by the solid line (Path B).

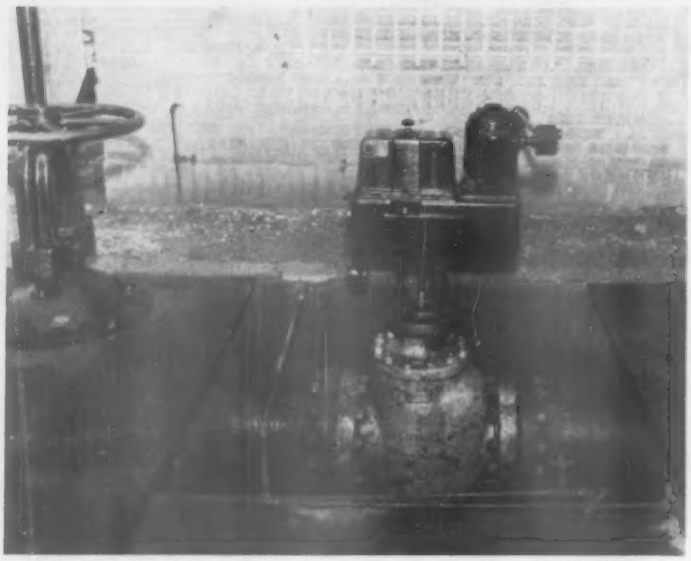
The hydraulic nomograph and power curves, as developed, have provided a simple and direct solution to the selection of optimum pump combination at minimum power costs.



VAN, TEX.-SMITHS BLUFF pipeline map shows route of old system which has been modernized.



LEFT TO RIGHT are shown motor-control supervisory control, sequence control, and electronic control for control valve. Pressure telemetering transmitters are on front door of supervisory at Rusk station.



CONTROL VALVE with electro-hydraulic actuator on the downstream side of the station is shown at Rusk.

Pure Transportation completes

Automation of Texas trunk line

Automation has proved to be a beneficial change. It has reduced operating costs and major mechanical maintenance of pumps because of improved protection of units. Telemetering operating data to a central point has permitted operations which previously were considered impractical.

BY R. M. THOMAN AND G. J. WILLER, JR.
General Engineering Department, Pure Oil Co.

AUTOMATION of a 10-in. crude-oil pipeline from Van, Tex., to Pure Oil Co.'s Smiths Bluff refinery at Nederland, Tex., was recently completed by Pure Transportation Co.

The line is 210 miles long with six stations located at approximately 35-mile intervals. The pumping equipment consists of three three-stage pumps driven by 400-hp. motors at

TGT BUILDS another big one

To help supply what has been described as "Chicago's seemingly endless requirements for industrial and space-heating gas," Tennessee Gas Transmission Company has a big new pipeline scheduled for operation this fall.

The 30-inch line, owned by Midwestern Gas Transmission Company, a TGT subsidiary, stretches 351 miles from Portland, Tennessee, to Joliet, where initially it will deliver 255 million cubic feet of natural gas per day to utilities serving the Chicago area, increasing to 360 million cubic feet daily by the third year.

Enroute to Chicago, the line crosses six major rivers, 20 streams and canals, and 49 pipelines. Field engineering began last February; construction started in July.

Bechtel services to its long-time client on this project included all field engineering, right-of-way acquisition, double-jointing some 170 miles of 30-inch pipe and construction of 148 miles of the line.

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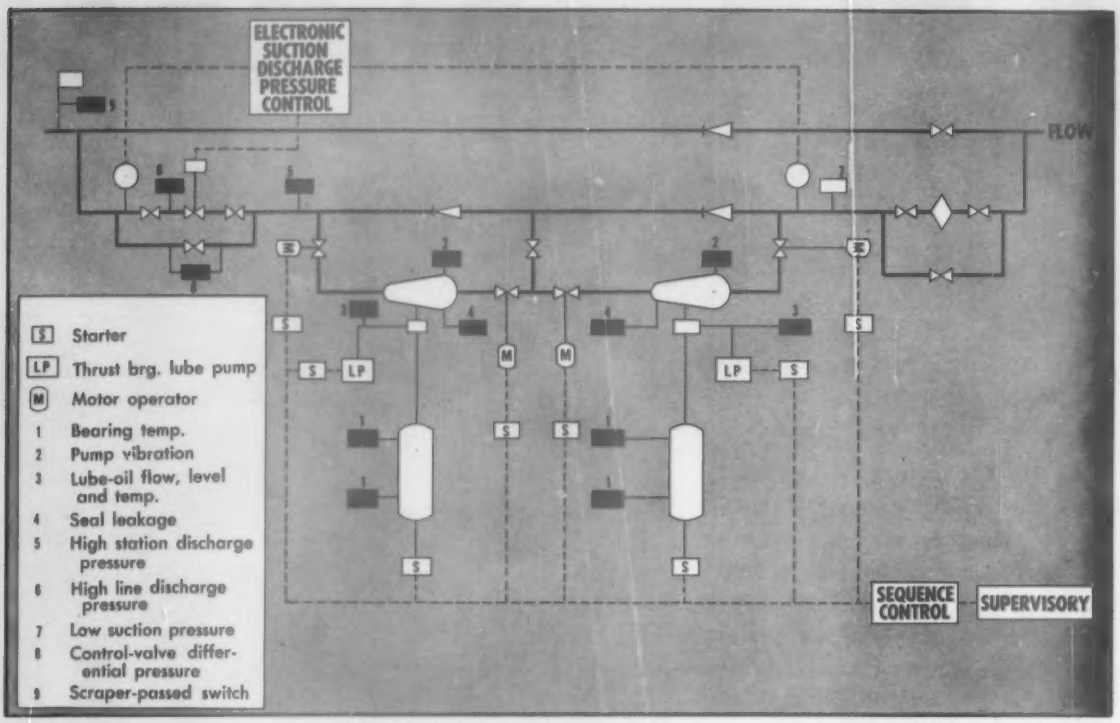

SCHEMATIC DIAGRAM of two-unit station shows layout.

each of the three main stations, and two three-stage pumps driven by 400-hp. motors at each of the three intermediate stations.

The program for automation of this line was started in 1956. The objective was to provide for the operation of four booster stations (Rusk, Diboll, Woodville, and Nona) from a central point (Van station). These stations were placed in full operation on supervisory control by November 1957.

A fifth station (Bullard) was added to the supervisory control system and placed in operation March 1, 1959, thereby completing the automation of the entire line. The Bullard station was not included in the original program because of custody-transfer operations from a connecting carrier. However, experience gained in operating the previously automated stations indicated that this station could also be operated from the central point with attendance only during the custody-transfer operation.

Reduced costs . . . Automation of this pipeline has proved to be a beneficial change and has reduced operating costs. Although dollar value is difficult to determine, telemetering operating data to a central point has permitted operations which were previously considered impractical. The improved protection of units and stations has reduced major mechanical maintenance of pumps.

The system presented some interesting problems as the pipeline is approximately 30 years old and the stations did not lend themselves to automatic control without modifications of piping, scraper traps, pumps, and valves. With the exception of the 400-hp. motors, 2,300-volt cables, and lighting all electrical equipment was replaced.

Communication Circuit

In the planning stages, it was obvious that the proposed installation of supervisory control would require a reliable communication circuit and the existing company-owned physical pair was not deemed satisfactory. Much of the pipeline and pole line right-of-way is through the wooded areas of East Texas and presented difficult maintenance problems. The economics of anticipated maintenance of the existing physical pair favored use of a leased circuit, provided a single

About the authors . . .

R. M. THOMAN has been employed as an electrical engineer in the general engineering department of Pure Oil Co. since February 1956. He served as project engineer for this project and was responsible for the electrical design and coordination. Before joining Pure, he was employed by Allis-Chalmers in various capacities. He is a graduate of Kansas State University where he received his BS in electrical engineering in 1952.

G. J. WILLER, Jr., is process engineer, in Pure's general engineering department, Chicago. He has been with Pure since 1950 when he obtained the BME degree from Renssalaer Polytechnic Institute. Miller joined the general engineering department staff after 2 years in the company's refining division.

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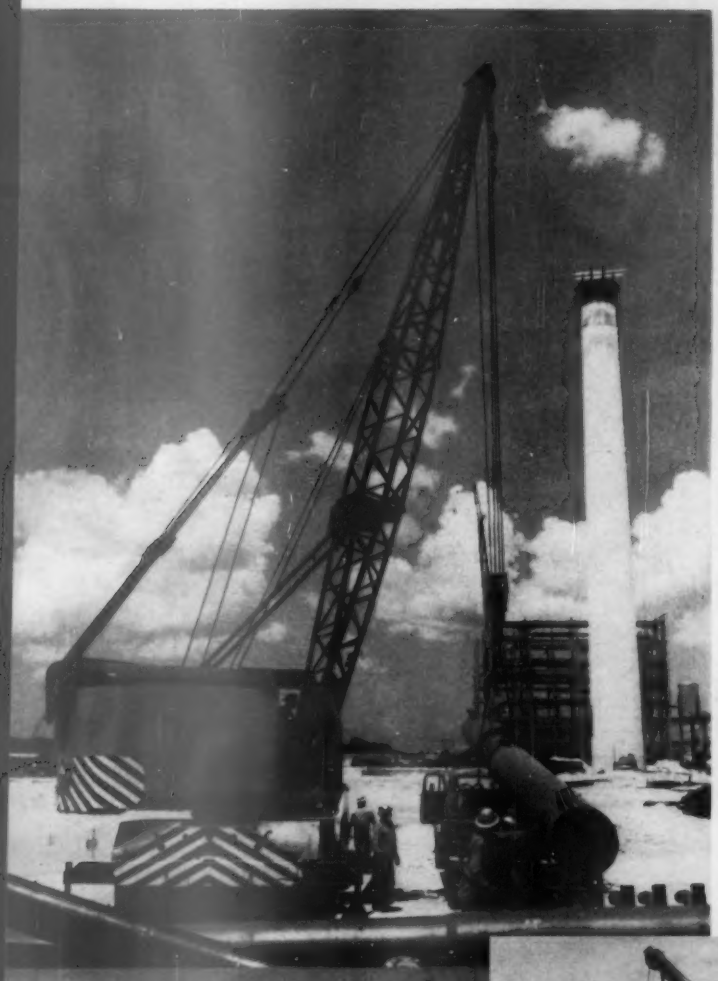

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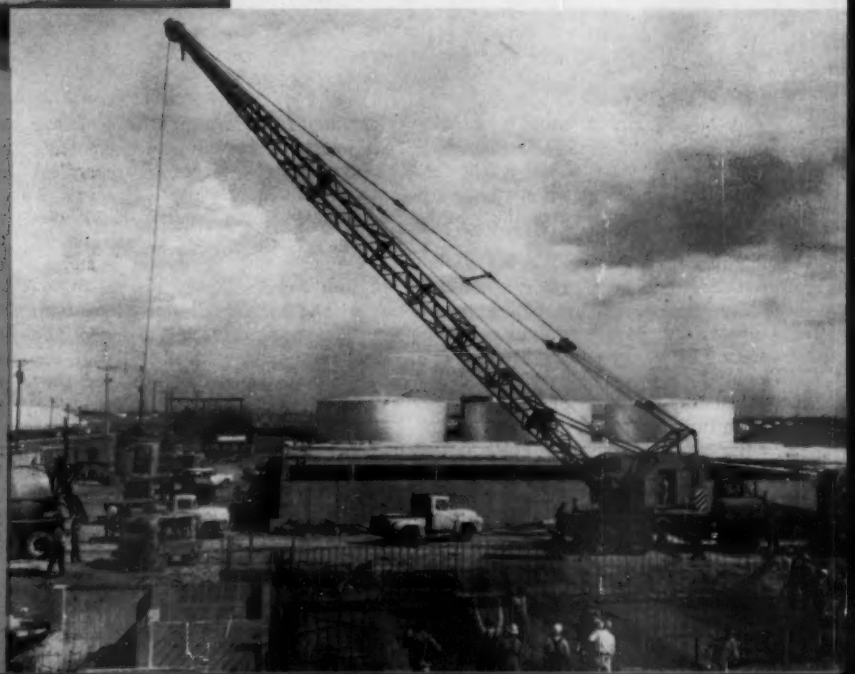

C-25-36-L

TABLE 1—PROTECTIVE FUNCTIONS AND GROUPING OF SUPERVISORY INDICATIONS AT TWO-UNIT STATION

Item	Protective device	Local annunciator	Unit shutdown and lockout	Station shutdown	Station lockout	Supervisory signal to Van and common alarm
1	No. 1 Inboard-motor bearing temperature	A1	X			
2	No. 2 Inboard-motor bearing temperature	A2	X			S1
3	No. 1 Outboard-motor bearing temperature	A3	X			
4	No. 2 Outboard-motor bearing temperature	A4	X			
5	No. 1 Pump vibration cutout	A5	X			
6	No. 2 Pump vibration cutout	A6	X			S2
7	No. 1 Pump lube temperature	A7	X			S3
8	No. 2 Pump lube temperature	A8	X			
9	No. 1 Pump lube oil level	A9	X			
10	No. 2 Pump lube oil level	A10	X			S4
11	No. 1 Pump lube oil flow	A11				
12	No. 2 Pump lube oil flow	A12				S5
13	No. 1 Seal leakage	A13		X	X	
14	No. 2 Seal leakage	A14		X	X	S6
15	No. 1 Motor overload	A15	X			
16	No. 2 Motor overload	A16	X			S7
17	High line discharge pressure	A17		X		S8
18	Low line suction pressure	A18		X		S9
19	High station discharge pressure	A19		X		S10
20	Pressure control-valve differential pressure	A20		X		S11
21	No. 1 Incomplete sequence	A21	X	(Without lockout)		
22	No. 2 Incomplete sequence	A22	X	(Without lockout)		S12
23	Fire detector	A23		X	X	S13
24	High sump level	A23	Not a shutdown device. (Supervisory signal only)			S14
25	No. 1 Pumping unit (stopped)					S15
26	No. 1 Pumping unit (running)		Not protective device. (Supervisory signals associated with control indicates completion of start-and-stop sequence)			S16
27	No. 2 Pumping unit (stopped)					S17
28	No. 2 Pumping unit (running)					S18
29	Position of local remote-transfer switch		Not a protective device. (Supervisory signal only)			S19
30	Power restored		Not a protective device. (Supervisory signal only)			S20
31	Scraper passed					S21

voice-quality circuit could accommodate supervisory control, telemetering, and the necessary voice traffic between the Van dispatch station, various other stations, and the Smiths Bluff refinery.

This initial consideration led to what is believed to be a unique communication link; accommodating voice, supervisory control, continuous telemetering of 10 pressure indications (except during voice traffic) and "as called for" telemetering of tank gages from Bullard station, on a single nominal 300 to 2,700-cycle voice circuit leased from Southwestern Bell Telephone Co. This circuit serves seven individual locations spaced approximately 35 miles apart.

Planning . . . During the planning stages these operating requirements were considered necessary regardless of circuit requirements:

- Telemetered suction and discharge pressure from all stations at any time a unit or station is started or shut down.
- The individual stations were to be completely protected and continue operating even with the loss of the communication circuit provided they were not shut down by local protective devices.
- Any shutdown of a unit or station was to be indicated at the dispatch station even when the circuit was being used for voice.

While these items were considered essential, certain operating procedures were accepted to permit the multipurpose use of a single-voice circuit:

1. Normal operating reports and routine voice traffic are scheduled for the quarter hour whereas routine indication checks, tank gages, etc., are obtained on the hour and half hour. Only emergency voice traffic is allowed during periods of electrical storms and other conditions which may require frequent use of the supervisory control and telemetered data.
2. The dispatch operator has full authority to clear all voice traffic from the circuit any time upset conditions require continuous use of the circuit for supervisory and telemetering.

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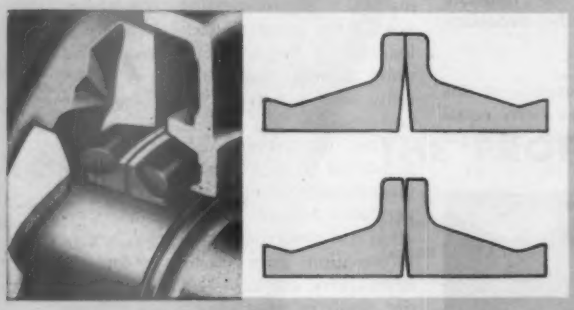

lapped faces . . . smoother than glass. These faces taper slightly toward the inner edge forming a sealing area at the outer edge. As wear occurs, the sealing area moves inward, maintaining a perfect seal through thousands of hours.

The "O" rings keep constant pressure on the metal rings. Lubricant can't get out. Grit can't get in. There are no springs or diaphragms to weaken, wear or become damaged. "O" rings are made of special compound to resist oil, heat and cold.

Millions of hours of proof—the toughest track roller yet. Cat lifetime lubricated rollers have been subjected to extensive and exhaustive on-the-job tests *for over 5 years.* Working under all types of job conditions, these time-tested rollers have proven unequalled. Their success is further amplified by new machine owner reports—for low-cost performance and minimum maintenance, Cat lifetime lubricated rollers can't be beat.

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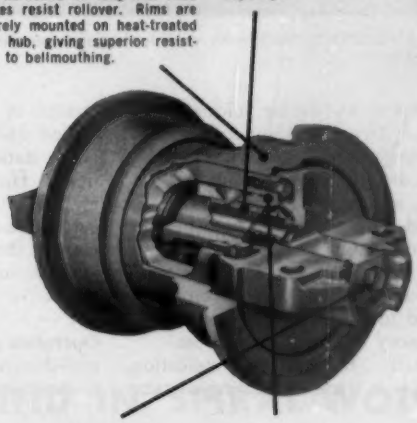

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SERVICE TIP: When rebuild time finally comes, be sure to keep the metal rings matched in original pairs, being careful not to nick or mar the lapped faces.

TYPICAL PUMPING UNIT with seal leakage, lube-oil level, and flow devices on Van-Smiths Bluff line.

3. Ordinarily, during voice use, the circuit is free of all supervisory and telemetering tones. If, during voice use, a status change occurs at any station, a return indication "tone" is imposed on the circuit. Upon hearing this audible tone, all parties using the circuit for voice traffic discontinue their conversations and the circuit is released to the dispatch operator for supervisory and telemetering use.

Actually the return indication, (which is a signal indicating a status change of some function at a controlled station) is received at the dispatch station even though voice continues. However, since all telemetering is off the circuit during voice use, immediate release of the circuit allows the dispatcher to reinstate telemetering and take the necessary corrective action.

Operation good . . . Operation of this multifunction circuit has been equal to expectations in most cases. As might be expected, problems which had not been anticipated developed during the engineering stages and a few "bugs" remained to be eliminated during the first period of operation. After the routing of the telephone circuit had been established, it became evident that it would not be possible to use any frequency above 2,762 c.p.s.

This necessitated special consideration when adding the fifth station on the same circuit and it became necessary to use frequency-shift equipment for the last two channels available in the lower end of the band.

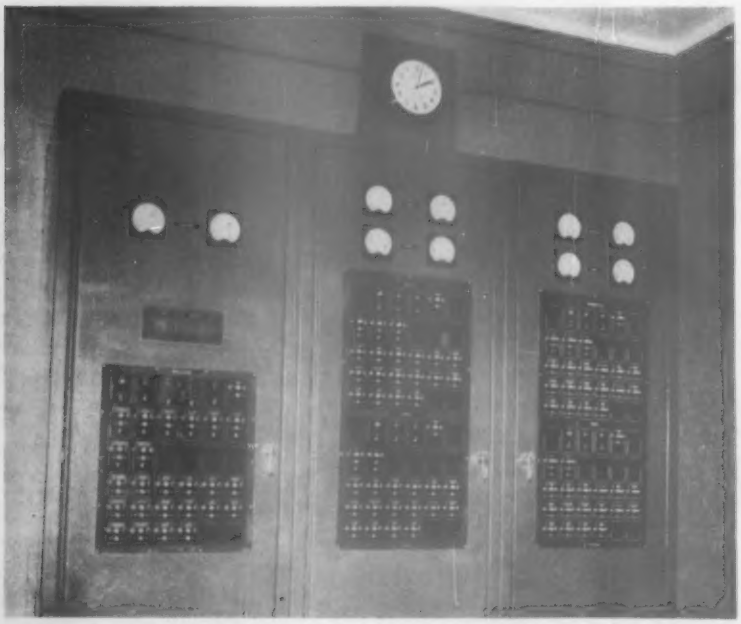
The primary difficulty encountered during the initial operation was the interference of voice with the "return indication" or call-back function of the supervisory control. The original requirements of Southwestern Bell dictated that any individual tone input be approximately 10 db. below voice level and that the oscillator output of any tone at any point was limited to 0 dbm. (decibel milliwatt).

This resulted in a receiving level of approximately —25 to —30 dbm. The equipment was designed to operate at these levels. However, as might be expected, it was necessary that the receiving amplifier of the supervisory control equipment have a high gain setting. As the supervisory control remained connected to the circuit during voice communication, the higher voice level resulted in excessive overloading of the frequency responsive units, thereby causing a loss of selectivity and interference during voice conversation.

This interference should not be construed as a misoperation or misinformation taking place via the supervisory control. In fact, a misoperation has never occurred nor has misinformation been received via the supervisory control. The interference did result in simulating a report-back frequency from a station and initiating an indication check. If the noise due to voice continues, the indication-check cycle is subject to error and consequent blackout of the board indicating an erroneous return indication.

Actually, the design of the supervisory control had anticipated the possibility of voice initiating an indication check and was so designed that the first frequency used for report-back had to exist on the circuit for a given period. However, the high voice level resulted in triggering the frequency responsive unit for long periods and initiating an indication check.

Problem solved . . . This problem was solved by modifying each telephone connected to the circuit to attenuate



SUPERVISORY CONTROL for five stations is located at dispatch station.

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the voice frequencies which were initiating an indication check. These modifications had little or no effect on the quality of voice conversation.

The supervisory control has priority on the circuit, but the circuit is still used on an alternate basis. Supervisory control and telemetering audio tones will definitely interfere with voice conversation and tend to make it unintelligible, but the voice conversation will not interfere with the function of the supervisory control.

The continuous telemetering of 10 variables also makes use of an audio-frequency channel for each variable. These tones are on the circuit at all times except for periods of voice communication. To use the circuit for voice communications, the tones are removed from the circuit by a ringing code operated through the Southwestern Bell facilities.

Supervisory Control

With the automation of the last station, the supervisory control provides for the control of 12 pumping units located at five different stations, the selection of two tanks at Bullard station to be remotely gaged, and the control of two line block valves with provision for the future control of four tank valves at Bullard station.

Table 1 lists the protective functions and the grouping of supervisory indications for each of the two unit stations. This tabulation also lists the functions which are unit shutdown and lockout, station shutdown, station lockout, and functions with local annunciator indications at each station. The three unit stations have an identical arrangement except that the functions for the third unit are included in each group.

Sequential tones . . . The supervisory control employs sequential audio tones. Frequencies of 2,592, 2,677, 2,762, 2,167, and 2,252 c.p.s. are used as control frequencies being transmitted from the dispatch station to all controlled stations. The selection and operation of any station unit is determined by the proper sequence of four different audio frequencies and the time space between pulses.

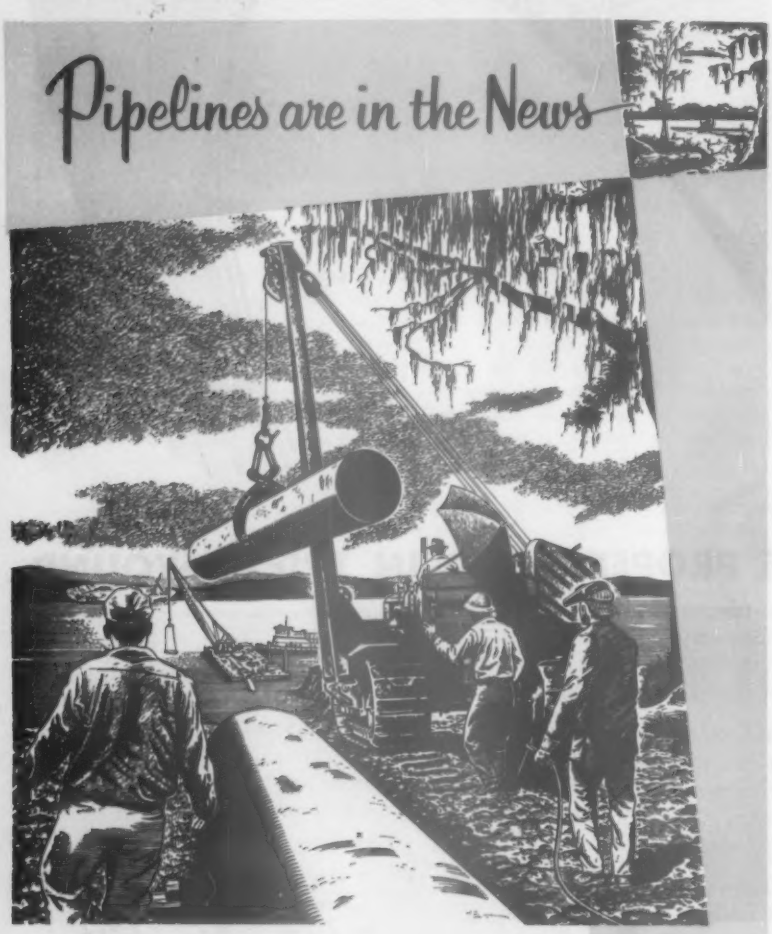
Although a controlled station operation is basically selected by a sequence of frequencies, there are many safeguards to insure that there will be no misoperation. To perform any operation, the following conditions must be met:

- The correct sequence of four specific frequencies must be received.
- Each 0.4 second frequency pulse must be received within 0.2 second of the last pulse in the sequence.
- The fifth frequency is pulsed simultaneously with each of the sequenced pulses. This means that any spurious signal must consist of two specific frequencies before it can simulate one signal in the chain.
- If a spurious signal, other than the selected frequency, occurs simultaneously with the selected frequency, the signal will be rejected.

It is difficult to conceive how any spurious signal could meet all of the conditions necessary to cause misoperation. This system has been in use for the control of four stations for some 18 months; actual operation has verified the absolute security of the system even though it is subject to large amounts of "noise" due to the voice traffic on a common circuit.

Frequencies of 2,337, 2,422, and 2,507 c.p.s. are used as return indications or call back. All three frequencies are transmitted from each of the controlled stations for return indications. The station reporting is identified by the number of pulses of a specified frequency transmitted to the dispatch station. If an erroneous signal results in the selection of a wrong station panel at the dispatch station, an error is detected and all indications for the station selected are blacked out.

A check at the end of the indica-



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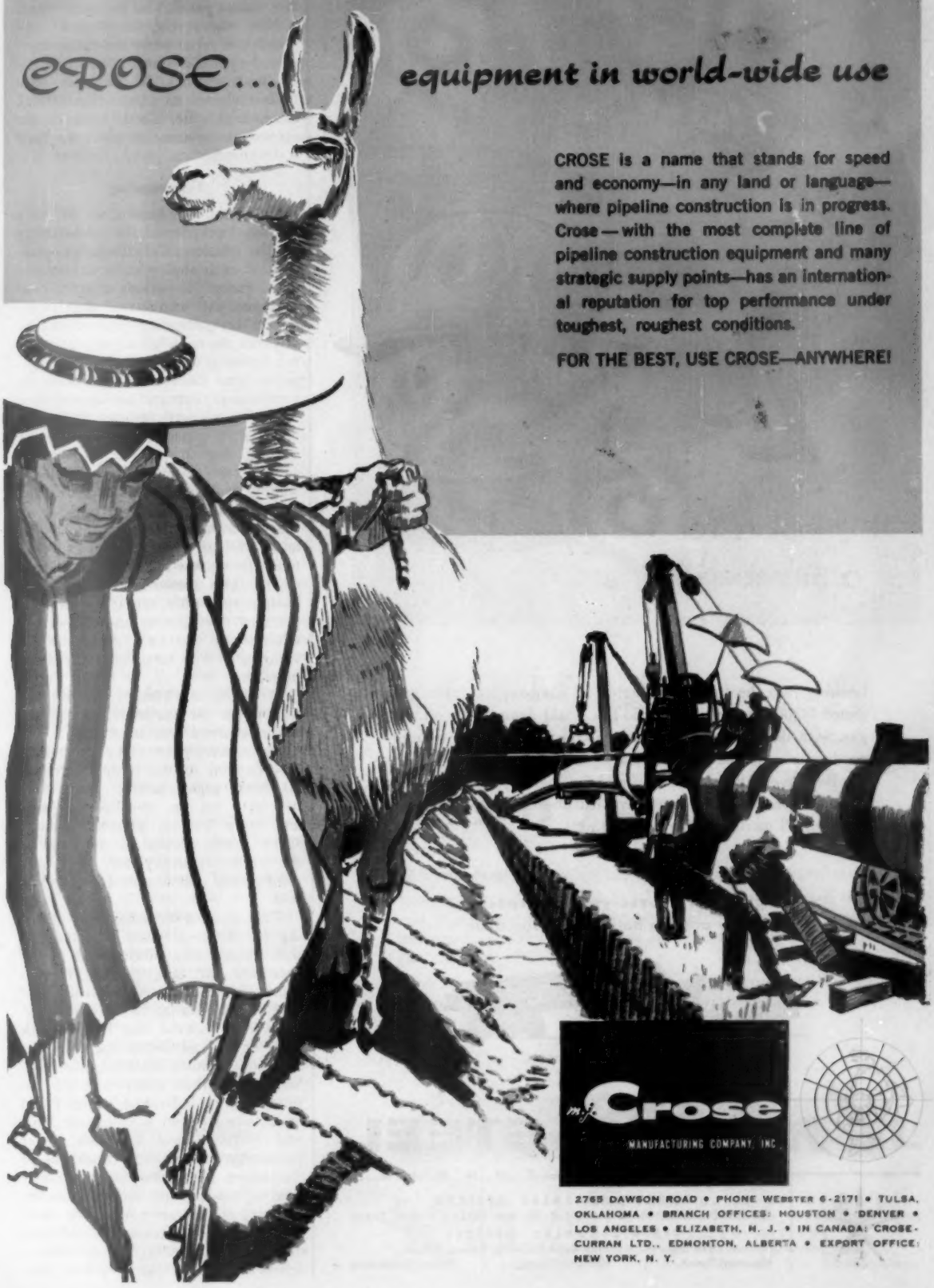

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tion also identifies the station which actually reported in and "blacks out" this station panel. This indicates which station was trying to "report" and which one reported in error; the operator then initiates an indication check on both stations. There have been cases where an indication check blacked out the board; however, no erroneous information has ever been transmitted.

Telemetering

The original installation of four stations incorporated the telemetering of the suction and discharge pressure of each station on a continuous basis, except for periods of voice conversation. All telemetered data is received on indicating meters at the dispatch station. All of the pressure telemetering is analog time-ratio impulse type. Each of the telemetering transmitters operate on a specified frequency channel between 765 c.p.s. and 1,955 c.p.s. with a 170-cycle spacing.

With the installation of Bullard station, it was also desired to have the suction and discharge pressure of the station telemetered, as well as the tank level of two tanks. Digital-type telemetering was selected for the tank gaging. The transmission of both the analog time-ratio duration impulse pressure telemetering and the digital telemetering for tank gaging is accomplished with frequency-shift transmission.

With the addition of the Bullard station on the common circuit, the entire channel was used and it became necessary to make one slight modification in the basic operation. As tank gage readings were only necessary on an as-called-for basis and there was no adjacent channel space, it was decided to make use of the same frequency for both tank gaging and suction-pressure indication.

This required the acceptance of losing the suction-pressure indication for this station only, during the period necessary for tank gaging. This is some compromise on the feature of continuous pressure indications, however, it is believed that it will work well for this particular operation.

In continuous telemetering an operator can scan these meters in much less time than 10 individual values could be obtained on an as-called-for basis and thereby have a much better knowledge of operating conditions of the entire line. This is particularly true on this pipeline, inasmuch as the booster stations are relatively close together and pressure conditions change quite rapidly. The continuous telemetering has also provided addi-

tional assurance to the operators during startup and shutdown of units and stations.

The telemetering system used for pressure indications is a relatively high-speed system. Starting from 0, the receiver will indicate 99% of full-scale reading in less than 3 seconds and, therefore, the operator can closely observe pressure conditions at all stations during startup.

Sequencing

The sequencing equipment used provides for the startup and shutdown sequence. The startup sequence is as follows:

1. Upon receipt of the supervisory start signal or a local start signal for a unit, the unit suction valve starts opening and simultaneously the thrust-bearing lube pump is energized.
2. When the suction valve reaches 60% open, the discharge valve is energized and begins to open.
3. When the discharge valve has reached 20% open, and provided thrust-bearing lube-oil flow is detected, the 400-hp. reduced-voltage starter is energized.
4. When the discharge valve reaches the full open position, the thrust-bearing lubrication pump (which is used during starting only) is shut down and the sequence is complete.
5. If this entire sequence is completed within a specified time, the dispatch operator is advised by a return indication that the unit has sequenced completely and is on the line. Should all of these conditions not be met within a specified period of time, an incomplete sequence timer shuts the unit down and returns all valves to the closed position.

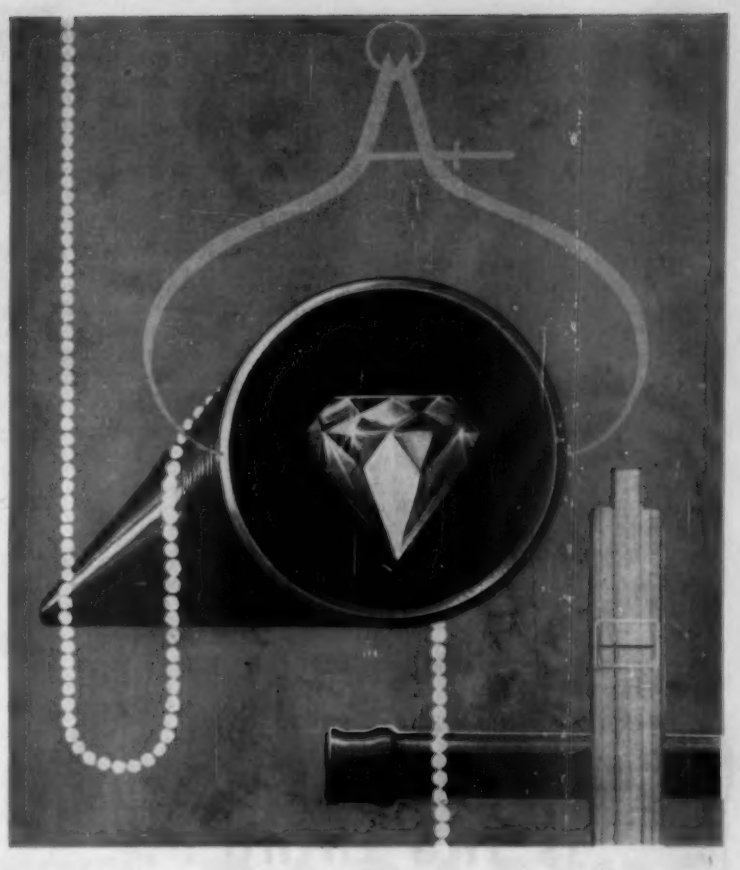
The shutdown of any unit requires that both the suction and discharge valve to that unit be closed, as well as the 400-hp. motor being deenergized. The system is so interlocked that both the suction and discharge valve must be fully closed before a new start sequence can be started.

On a primary power failure, the 400-hp. motors are deenergized, and, since all power is lost, the valves cannot be closed. Upon restoration of power, a time-delay relay energizes the shutdown system and returns the valves of all units to the closed position.

Protective Functions

Table 1 lists the protective functions incorporated. In addition to these, undervoltage, phase reversal, and overload protection are provided for all motors.

Bearing-temperature and case-temperature protection were not used on



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the pumps. Consideration was given to these devices but the design of the pumps, which were installed in 1929, made installation of such devices difficult, if not impossible. Vibration detectors were installed and have proven to be very sensitive to abnormal vibration. It is expected that these devices will serve adequately as bearing protection.

The lube-oil level, flow and temperature protection refer to the lube system for the Kingsbury thrust bearing incorporated in the pump.

The control-valve differential-pressure protection shuts down the station if the differential across the valve exceeds a predetermined valve. This provides an economical method of preventing excessive throttling to maintain suction pressure. If a bad line break occurs either upstream or downstream of the station, the control valve will throttle excessively to maintain suction pressure and consequently shut down the station.

Suction-Discharge Pressure Control

Variation in throughputs and crude gravities dictated the installation of automatic suction-discharge pressure controls. Before unattended operation, pressure conditions were maintained by manually pinching a gate valve on the downstream side of the station. Consideration was given to both pneumatic and electronic control systems.

Pneumatic control was rejected on the basis of expected difficulties with an unattended air-compression and drying system. It is believed that the cost of the electronic control system and electrohydraulic actuator installed was less than the cost of a complete pneumatic system.

The control loops consist of miniature, 0.5-5 ma. d.c. electronic instruments positioning 8-in. 600 psi. double-ported control valves through jet-pipe electrohydraulic topworks. The controller incorporates proportional and reset modes.

To provide control-system sensitivity, the suction-pressure transmitter was selected with a 0.5-psi. range. These devices are frequently subjected to pressures of approximately 500 psi. and an overrange protective device was used without much success. Tests of several overrange devices did not provide a satisfactory solution.

The standard pressure transmitter was abandoned in favor of a bellows-type differential pressure transmitter with a 0-50-psi. range. The high-pressure side was connected to the pressure source and the low-pressure side was vented to atmosphere. This provided a low operating range with dependable overrange protection to 1,000 psi.

To prevent overloading the valve operator, a specially designed nonseating double-ported inner valve is used in the control valve. This design contributed to a very flat valve characteristic curve near the open position.

Pump Modifications

The main-line pumps were originally fitted with conventional shaft packing. This was replaced with balanced mechanical seals. The rotating seal faces are stellited stainless steel against stationary graphite faces. Our experience with service life of the graphite faces has been good; however, they tend to fail without warning. As replacements are required, leaded bronze faces are being substituted for the graphite.

Acknowledgment

The authors acknowledge Pure Transportation Co.'s engineering and operating departments' assistance in the system design. We specifically acknowledge the assistance of V. J. Ryba, pipeline engineer; J. A. Wisdom, superintendent of the Texas-Louisiana Division, and J. A. Ogden, assistant superintendent of the Texas-Louisiana Division.

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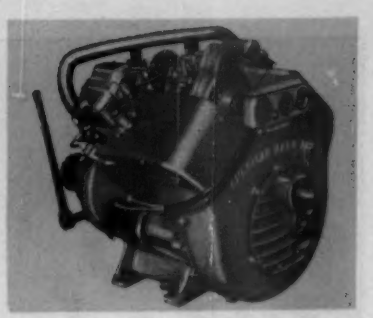

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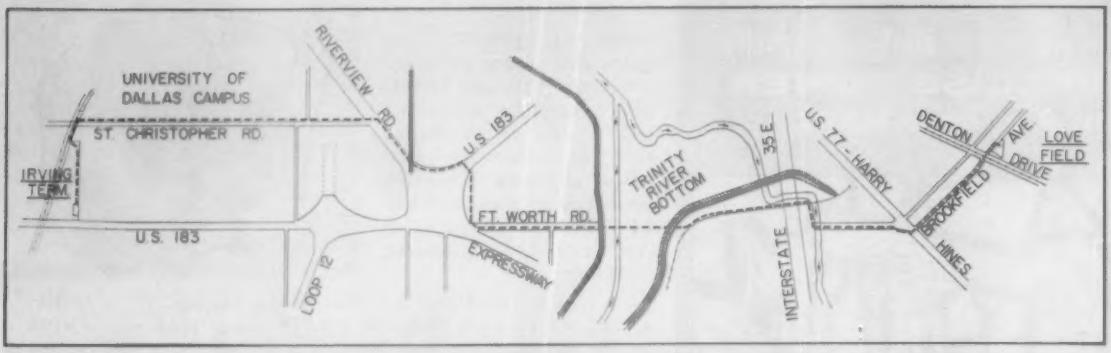
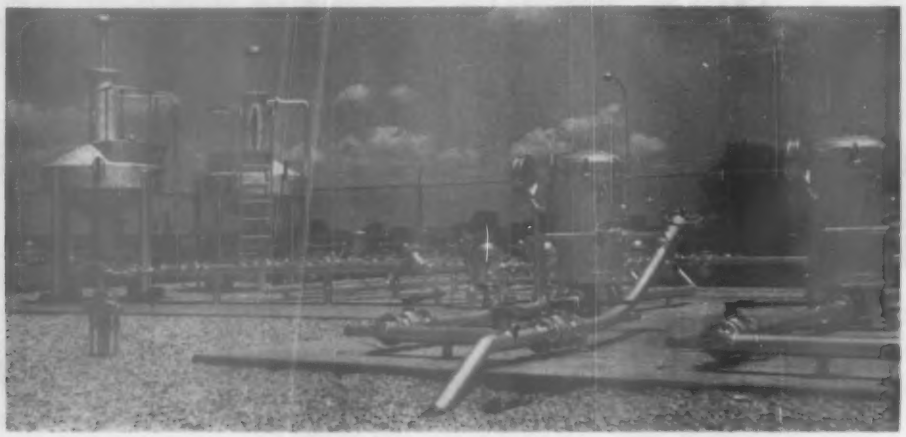


HUMBLE LINE runs from Irving terminal to Love Field, Dallas. Fig. 1.



METERING terminal has separate prover tanks for avgas and jet fuel.

How Love Field gets fuel by pipeline

• Jet-age fuel requirements will result in many more municipal airports being connected by pipeline. Experience of Humble indicates that the basic design of this system is sound and it may very well serve as a pattern for similar future installations for the company.

BY D. D. COMPTON AND H. E. BAHR
Humble Pipe Line Co., Houston

FIRST DELIVERY of aviation gasoline by pipeline was made to Love Field at Dallas on May 21, 1959. With the completion of a dual 4-in. system, Humble Pipe Line Co. made its first products pipeline extension to an airport and Love Field became the third municipal airport in the United States with a pipeline connection.

The fueling system at Love Field is owned and operated by Allied Aviation Fueling Co. of Dallas, Inc. Allied serves as an agent for the airlines but does not contract for their fuel requirements.

Allied's central underground storage and fuel-receiving facilities are located on a tract in the southwest portion of Love Field. Humble's metering terminal is also located here, and pipeline connection is made to seven of the twelve 50,000-gal. storage tanks. The remaining tanks are used to receive products delivered by truck from suppliers other than Humble.

Allied's continuously pressured underground-piping system links the storage area to conveniently located fueling hydrants.

Measurement of fuel delivered to planes is made with positive-displacement meters. Meters and filters are mounted on trucks and connection from hydrant to plane is made with flexible hose. A fall in pressure occasioned by opening a hydrant automatically starts the required pump. Pumps and filter-separators are located near the underground-storage tanks.

Humble's Products Pipeline System

The aviation gasolines and jet fuel delivered by Humble to Love Field are manufactured at Humble Oil & Refining Co.'s Baytown refinery. A 276-mile closed-system products pipeline, constructed in 1946, connects the refinery to marketing terminals serving the Houston, Hearne, Waco, Fort Worth, and Dallas areas.

One end of this line is Humble Pipe Line's Irving terminal. This terminal is located in the northeast portion of Irving, Tex., and fronts on U. S. Highway 183, connecting Dallas and Fort Worth. Positive-displacement

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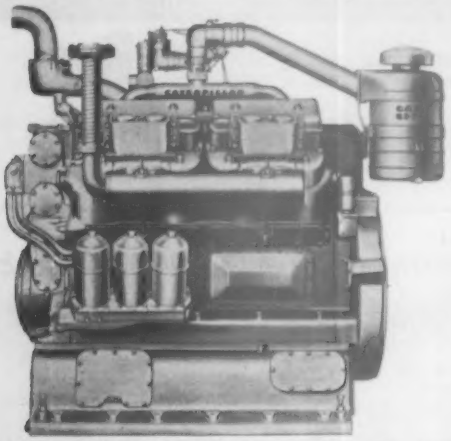
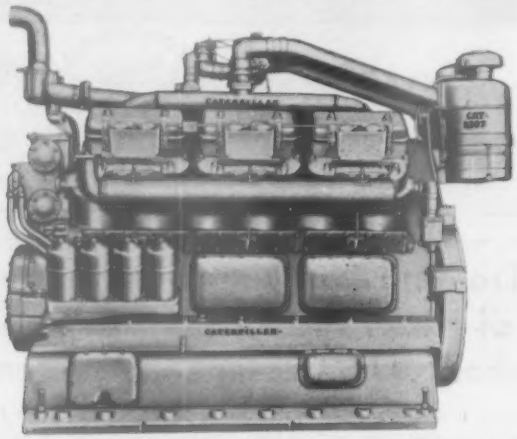
You can choose between two compression ratios. For operation on butane, propane or field gases, there is the 7.5:1 compression ratio. The 10:1 ratio—highest in the industry—is for operation with any methane-type gas. Of course, you can convert both engines to diesel from gas or vice versa simply by changing pistons and fuel systems. See your Caterpillar Dealer for complete new specifications—and to learn how they benefit your operation. Also, remember to specify Caterpillar for your oilfield equipment.



Rating for the G375 Natural Gas Engines, for continuous operation at 1300 RPM, without fan, now is 275 HP for 7.5:1 compression ratio. With the 10:1 ratio, it is 310 HP. New ratings for the G375 Natural Gas Electric Set with 10:1 compression ratio engine are 175 KW without fan, 160 KW with fan.



New ratings for the G397 Natural Gas Engines operating continuously at 1300 RPM without fan are 415 HP with 7.5:1 compression ratio and 470 HP with 10:1 ratio. New output for G397 Natural Gas Electric Set, with 10:1 compression is 275 KW without fan or 250 KW with fan.

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Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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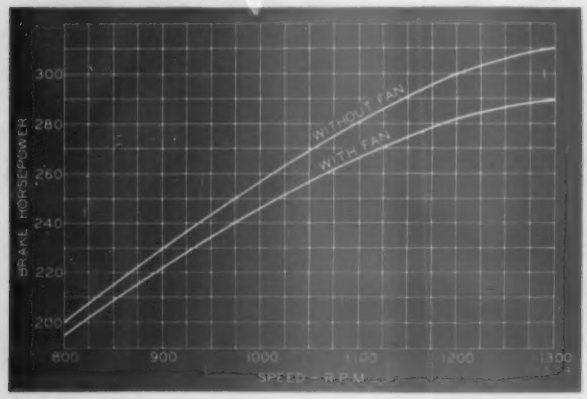
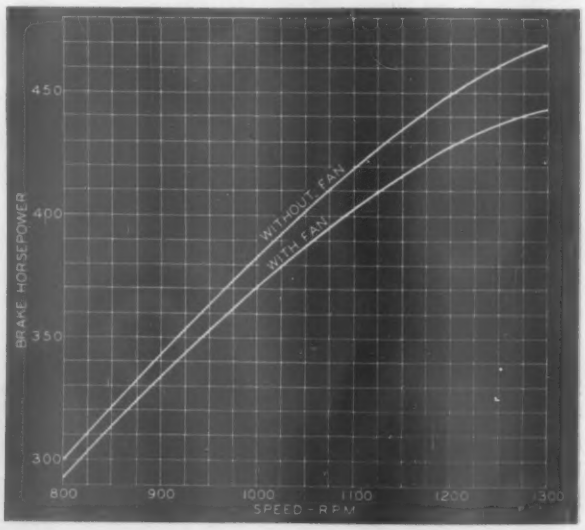
New Horsepower Curves for 10:1 CR Caterpillar Natural Gas Engines

G375



G397



meters are used for the custody-transfer measurement of products delivered to tankage of Humble Oil's adjoining North Texas marketing terminal. Three types of automotive motor fuel, two types of aviation gasoline, and two types of jet fuel are currently transported through the Baytown-Irving products pipeline.

The new extension consists of dual 4-in. pipelines, each 5.64 miles in length, from Irving terminal to Allied's receiving terminal. Jet fuel is delivered through one line and two grades of aviation gasolines are delivered through the other. Positive-displacement meters are used for custody-transfer measurement at both ends of the line.

Route of Lines

Airline distance between Irving terminal and Love Field is only 4.5 miles, but the pipeline route, as shown in Fig. 1, is 5.64 miles. The added length is due to the tortuous route through this congested urban area. All usable land along the route is occupied by two major industrial areas. These areas are separated by the low, marshy Trinity River bottom. The industrial districts are protected from flood water and by major levee systems on each side of the river.

At the pipeline crossing a diversion channel cuts off a large loop from the river and the old river bed serves local drainage only. The industrial districts are served by a network of roads, highways, and railroads. Three expressways and two traffic interchanges were under construction along and across the right-of-way at the time the pipelines were laid. As an indication of the number of major road crossings involved, 5,270 ft. of casing was required.

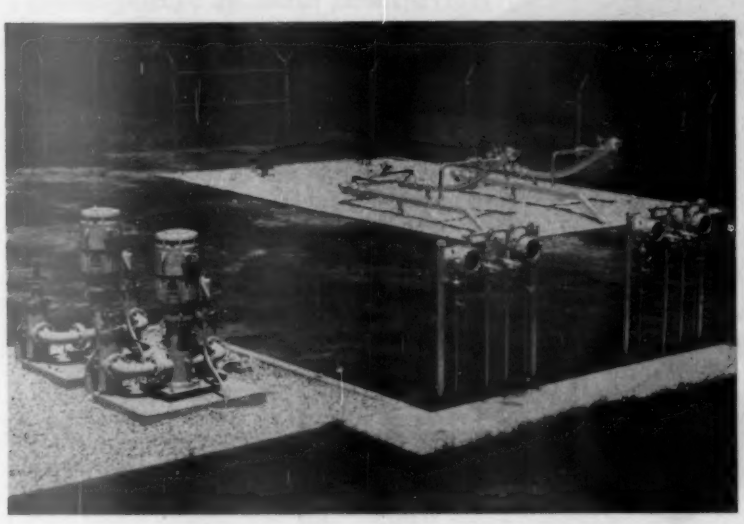
Right-of-way acquisition presented some unusual and expensive problems. Portions of the land traversed in the Trinity River area are an example. This land is underlain with a bed of good-quality gravel which is being mined by the open-pit method. It was necessary to purchase the unmined gravel as part of the right-of-way consideration. When approximately half of the right-of-way had been acquired, construction of the lines was started.

Construction of Pipelines

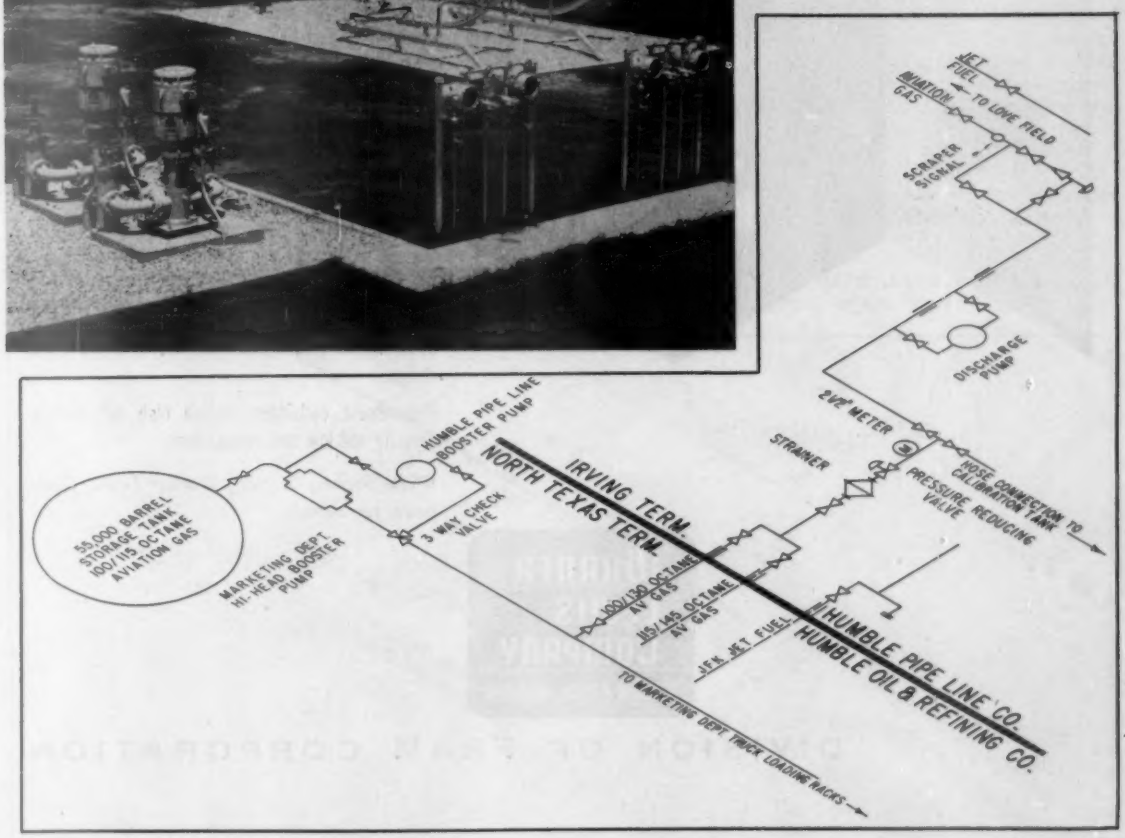
With the exception of certain specialty work, Humble Pipe Line constructed the system with its own forces. Contract equipment was used when necessary. To be certain that nothing was overlooked and to obtain the best possible construction, specifications were written as though it were a contract job. The spread was organized as for a trunk-line job, with inspector-foremen supervising each portion of the work. The welders had passed standard API welding tests and X-ray inspection was made of approximately 60% of the welds.

Two types of pipe were used in the lines: (1) 4-in., 10.79-lb./ft. API 5L Grade B seamless, and (2) 4-in., 10.79-lb./ft. API 5L Grade B continuous weld.

Approximately 7,000 ft. of new seamless pipe was laid from U. S.



DISCHARGE PUMP AREA at Irving terminal is pictured at left. Schematic layout at Irving is below. Fig. 2.



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Highway 77 into Love Field, this being the most congested area along the route. Here is a combination of industrial and residential areas with the lines being laid in a city street. For the remainder, new continuous-weld pipe was used.

Pipe was shipped to a coating contractor at Grand Prairie for cleaning and yard application of a double coat and double wrap in accordance with Humble Pipe Line Co.'s specifications. The contractor provided storage area for the coated pipe so that daily requirements could be loaded and strung.

Due to the congested areas, numerous road crossings, special construction requirements and, at places, skips due to right-of-way difficulties, the lines were laid in short sections. The spread from stringing to backfilling was very narrow.

Two strings of pipe were welded up on the previously prepared right-of-way prior to the ditching operation. A visual inspection was made of each weld. In addition, a radiographic inspection was made of selected welds. The radiographic inspection was made on all welds in roads or city streets, all welds in Trinity River bottom, all welds in levee and in water crossings, and spot check of remaining welds.

To assure uniform cross-section, all angles of 30° or greater were made by welding in 8-ft.-radius pipe bends. Field joints were wrapped using a PVC tape applied over an adhesive primer.

Minimum cover over the lines was specified to be 24 in. However, due to the many special deep-ditch requirements, the average pipe cover is 37 in. A 28-in.-wide ditch was cut with a wheel ditcher that pulled a special shoe to provide a flat bottom. At places where a deeper or wider trench was needed, backhoes were used for excavation.

Lines were lowered into the common ditch, holding as near as possible to a minimum separation of 18 in. Where the lines crossed major roads or highways, the spacing was increased so the lines could be inserted in previously installed individual 10-in. casings. There are 14 cased road and railroad crossings. The longest crossing is 522 ft. across Interstate Highway 35-E.

THE AUTHORS

Daniel D. Compton is senior engineer in the division services section of the technical department of Humble Pipe Line Co. at Houston, a post he has held since February of this year. He joined Humble Pipe Line in 1946 as junior engineer in the communications and electrical department. In 1956 he was assigned to the East Texas Division engineering department, and participated in the design of the Irving Love Field pipeline.

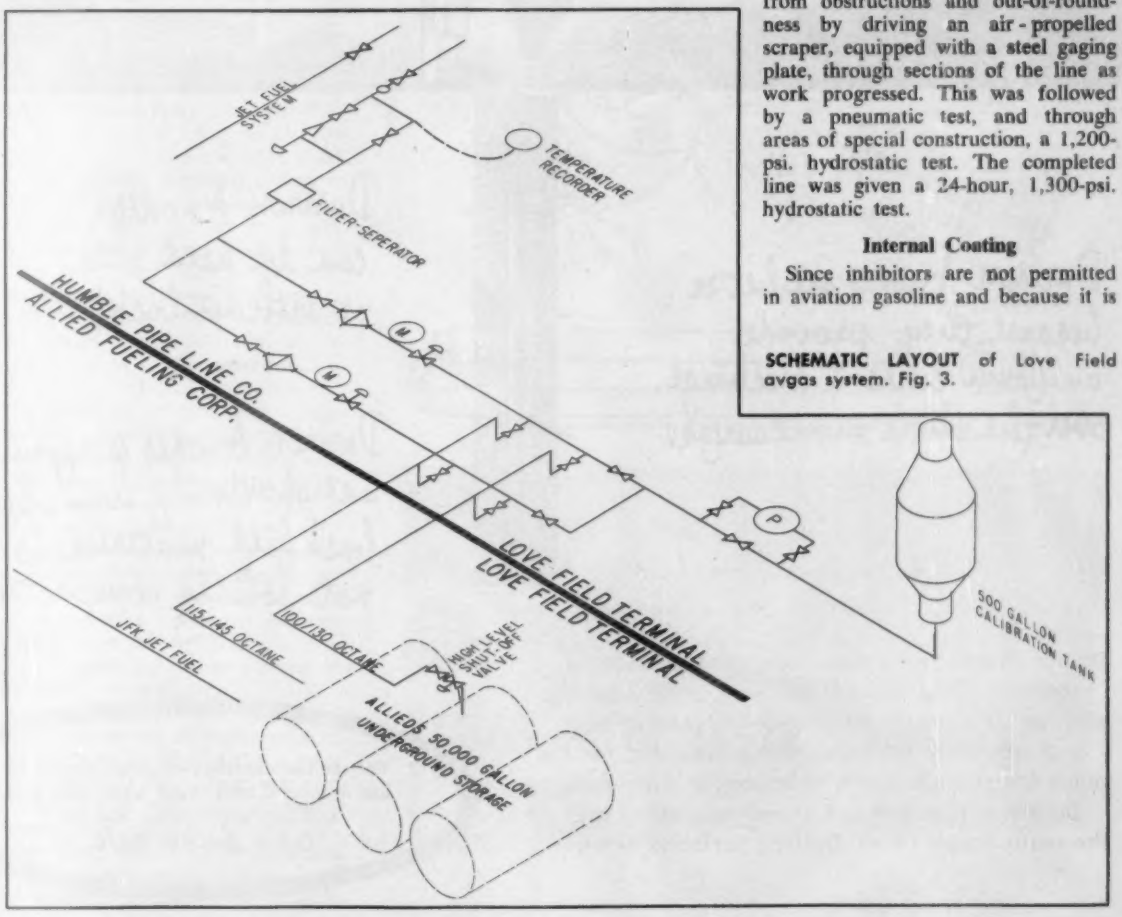
Harold E. Bahr is division engineer, East Texas Division, Humble Pipe Line. He is a 26-year veteran with the company, and for the past four sessions has served as instructor in design of gathering systems in the API-sponsored school of pipeline technology.

Some twenty-eight 32-lb. magnesium anodes with packaged backfill were used to provide cathodic protection. These were installed in five groups during construction of the line. Numerous test points were also installed.

The lines were tested for freedom from obstructions and out-of-roundness by driving an air-propelled scraper, equipped with a steel gaging plate, through sections of the line as work progressed. This was followed by a pneumatic test, and through areas of special construction, a 1,200-psi. hydrostatic test. The completed line was given a 24-hour, 1,300-psi. hydrostatic test.

Internal Coating

Since inhibitors are not permitted in aviation gasoline and because it is



SCHEMATIC LAYOUT of Love Field avgas system. Fig. 3.

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vitally important that all products delivered be as clean as possible, decision was made to internally coat both lines. Contract was awarded to clean the lines and coat them in place with Humble's epoxy pipeline coating, Red 665. This material had been under test for 6 months in product service and had proved to be entirely satisfactory.

Metal surface preparation was by a combination of mechanical and chemical means. Approximately 420 gal. of coating material were used to obtain a 5-mil.-thick coating. Cold, wet weather made this operation considerably more difficult than normal.

Irving Terminal Facilities

The equipment at Irving terminal is arranged to form two similar but separate systems. Fig. 2 shows schematically the layout of one system.

Humble's pumping equipment consists of three booster pumps and two discharge pumps.

The tank-farm booster units are vertical centrifugal pumps driven by 3 - hp. 1,750 - r.p.m., explosionproof electric motors. To allow reverse flow when calibrating marketing department's meters, three-way check valves were installed at booster tie-ins. The boosters are connected in parallel with marketing department's high-head loading-rack pumps. The two pumps are electrically interlocked so that the booster is energized only if a delivery is being made to Love Field and the related marketing pump is not operating. Pressure-reducing valves limit meter inlet pressure to 8 psi. when marketing's pump is being used.

The 4-in. lines, laid by Humble, extend from marketing department's loading-rack lines to the product-selection valves. The jet-fuel line ties in downstream of a filter-separator that provides 5-μ filtration of solids and 99% knockout of entrained water. The two aviation-gasoline lines tie in downstream of future filter locations.

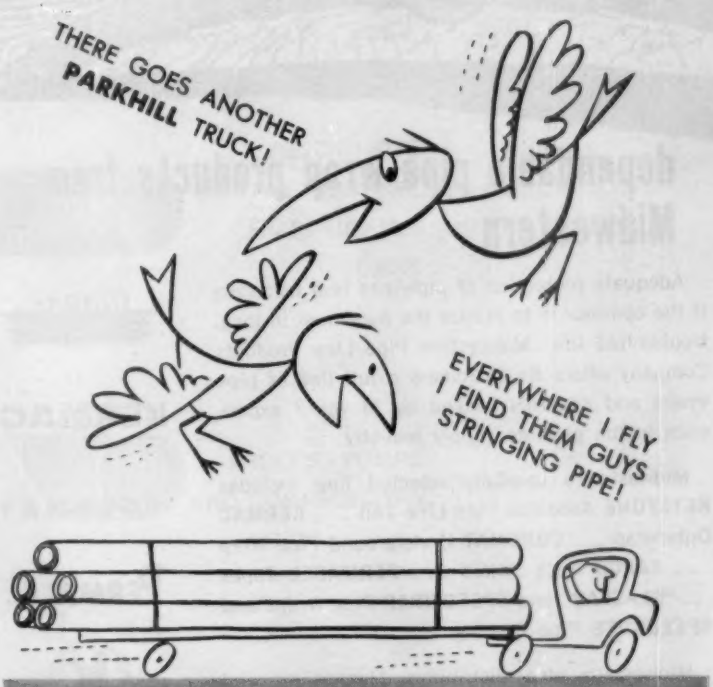
The product-selection valves are installed at the property-line fence as shown in Fig. 2. Here, the two aviation-gasoline lines from separate tankage are manifolded to the single 4-in. line, extending to the aviation-gasoline meter. Like valving is installed in the jet-fuel delivery line and provision is made for future connection of a second jet-fuel line.

Correct tank-farm lineup is assured by the installation of explosionproof limit switches on each aviation-gasoline manifold valve. These are used as interlocks in the electrical control scheme. The aviation - gasoline discharge pump cannot be started unless selected-product valve is fully open and alternate-product valve is fully closed. Anticipating the future handling of a second grade of jet fuel, a similar installation was made on the jet-fuel valve.

Two 2½-in. positive - displacement meters, one for each system, are installed for custody-transfer measurement of products withdrawn from marketing department's tankage. Meters are rated for a maximum flow of 240 g.p.m. and a working pressure of 230 psi. Each meter is equipped with: (1) temperature compensator, (2) "C" transmitter switch, (3) large numeral barrel counter-ticket printer combination. Four-inch strainers with 24 by 100-mesh monel screen protect the meters against migrant foreign material. During calibration, a 3-in. flexible hose connects the meter to a volumetric prover tank.

The discharge pumping units, one for each system, are multiple-stage can-type centrifugal pumps driven by 15 - hp. 1,750 - r.p.m. explosionproof electric motors. The aviation-gasoline pump, operating at 105 psi., delivers approximately 5,150 bbl. per day, while the jet-fuel pump, operating at 125 psi., delivers 4,750 bbl. per day.

Mounted on control racks, located near the discharge pumps, are the push-button stations for local start and stop of the pumping equipment together with suction and discharge-pressure switches for each system.



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Upsweep "sphere" entries are installed on each system. Here, liquid-inflated rubber spheres can be inserted in the lines and their departure indirectly observed by means of mechanical signals. At Allied's terminal, similar facilities are installed to observe the arrival of the spheres and to remove them from the lines. In the aviation-gasoline system, the spheres are used to separate the batches of 100/130 octane and 115/145 octane aviation gasolines. In the jet-fuel system, spheres are run periodically to sweep the line.

A 10-point annunciator panel, located in the office, provides visual and audible indication when the pumping equipment of either system stops as a result of abnormal suction or discharge pressure. Also located in the office is a remote meter-reading panel. Each meter at Irving and at Love Field is equipped to transmit one electrical impulse per barrel of throughput. The impulses actuate electric-operated counters which show throughput for each meter.

The counters for each system are arranged on the panel so that the companion meter at Love Field registers directly above the Irving meter. These same impulses actuate an add-subtract counter. A "difference" count of 5 is set on the add-subtract counter each morning. If, during a 24-hour period, Love Field receives five fewer barrels than Irving pumps, the add-subtract counter closes its contacts to energize a point on the annunciator. The visual and audible alarm identifies which system is short.

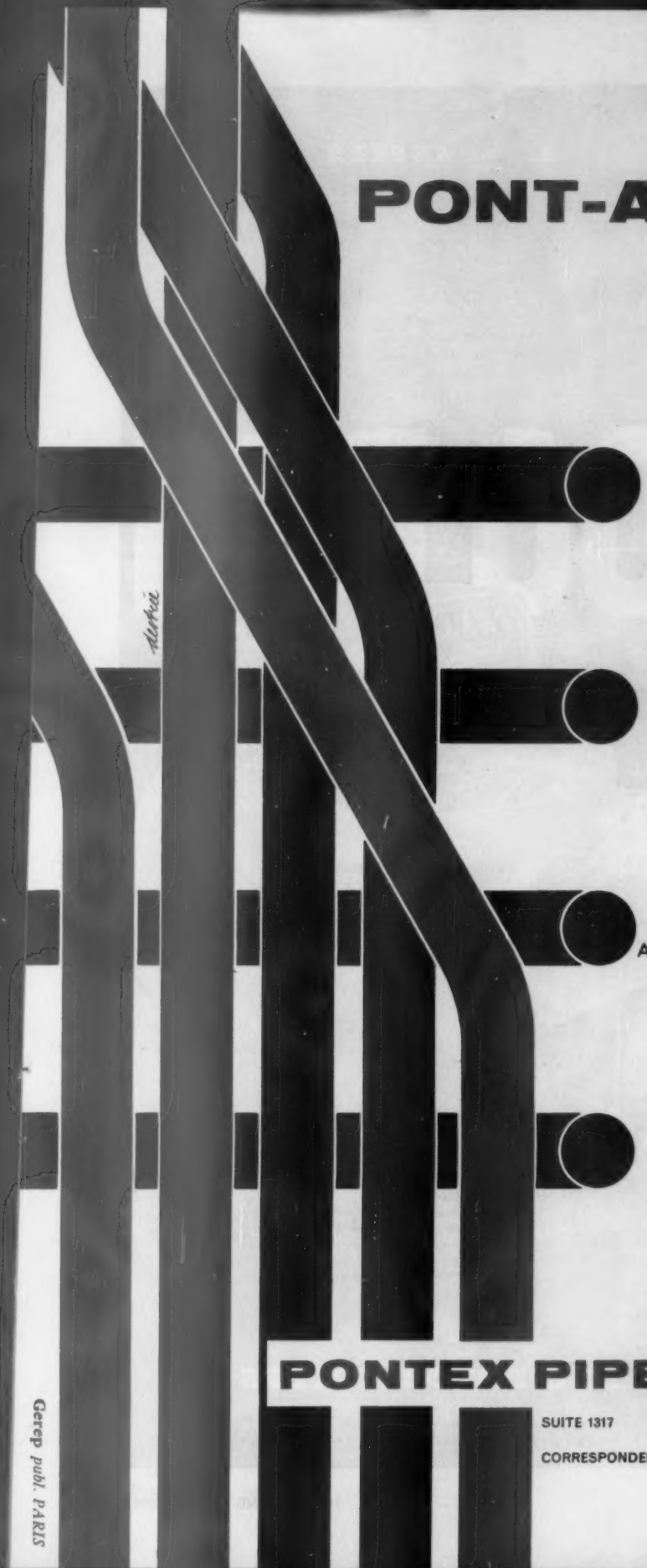
Metering Terminal

Humble's metering terminal is installed on a leased tract of approximately 0.1 acre in the west corner of Allied's Love Field terminal. Equipment is installed to form two similar but separate systems. Fig. 3 schematically depicts the arrangement of one system.

To assure delivery of clean products, vertical filter-separators are installed in each system. These filter-separators are rated at 250 g.p.m. and provide 5-μ filtration of solids and 99% knockout of entrained water.

Two positive-displacement meters are installed in each system, although only one meter at a time is used. The meters are identical to those installed at Irving.

A dual-purpose back-pressure regulator, equipped with a solenoid pilot for automatic operation, is installed downstream of each meter. To keep the lines packed, 21-psi. back pressure is held on the aviation-gasoline system and 25-psi. back pressure is held on the jet-fuel system. Back pressure



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on the gasoline line, in conjunction with the rubber spheres, permits shutdown of the line during a displacement without appreciable mixing. The back-pressure valve can also act as a block valve. An electrical circuit is opened when impulses from the meter reach the count set on a local predetermine counter. This deenergizes the solenoid pilot allowing the back-pressure valve to close, stopping all flow through the valve.

Because no mixture of an aviation gasoline and jet fuel is permissible, separate 500-gal. atmospheric calibration tanks are provided. A 2-in. pump powered by ⅓-hp. canned rotor motor is used to pump out the calibration tanks.

Products are delivered to Allied's underground tanks through three 4-in. lines. Allied's tankage reserved for pipeline delivery is allocated as follows: three tanks for 100/130 aviation gasoline, two tanks for 115/145 aviation gasoline, and two tanks for kerosine-type jet fuel. Connections between product headers and tanks are made through 4-in. nonlubricated ball valves and float-pilot actuated 3-in. diaphragm valves.

The diaphragm valves are used for high tank-level emergency shutoff. The float pilot causes modulated closure of its associated valve as the liquid approaches maximum-fill level.

Safety was a prime consideration in the design of this system. Since in all cases, stoppage of flow is the safest operation at the airport terminal, this design provides for shut down of the system under emergency or normal operations and by both manual and automatic means.

These shutdown safeguards at Love Field are: (1) by closing a block valve on the system (normally this is done at the incoming trap when a sphere is received but any valve may be closed to quickly shutoff the stream), (2) the actual delivery desired may be set on the predetermine counter and the back-pressure valve will close automatically upon completion of the delivery, and (3) the high tank-level emergency shutoff will prevent overfilling a tank and will shut down the system when the last tank is filled.

Initially, because of inexperience with this type of operation and certain internal accounting requirements of the companies involved, a large number of small deliveries were made. This resulted in an excessive number of delivery tickets. This situation has materially improved and still further improvements are being studied.

Experience indicates that the basic design of the system is sound and it may very well serve as a pattern for similar future installations.

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Engineering Progress Report

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Ethylene Glycol Scores High As Hydrate Inhibitor

In refrigeration-type gasoline recovery plants, the most widely used hydrate point depressant is diethylene glycol. But, ethylene glycol may offer certain advantages as a replacement in your plant, for example . . .

SELECTION GUIDE

ADVANTAGE	Ethylene Glycol	Diethylene Glycol
Hydrate Inhibition	GOOD	GOOD
Ease of Separation	BETTER	GOOD
Cost	LOWER	—
Vaporization Loss	LOW	LOWER
Solubility Loss	LOWER	LOW

HYDRATE INHIBITION

While both ethylene and diethylene glycol give good hydrate inhibition, with hydrate point depressions generally in the range of 60° to 80°F., reports indicate that ethylene glycol may give a greater depression in those cases needing very low separation temperatures.

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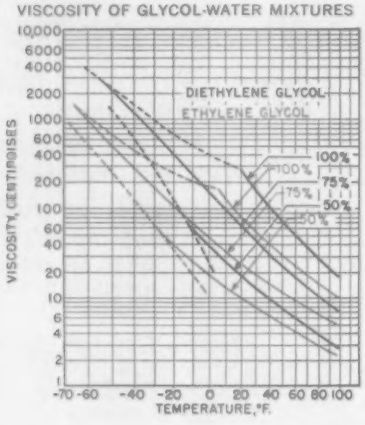
This advantage is illustrated in the graph below. At 0°F. the viscosity of a 50 per cent ethylene glycol solution is 20 centipoises, or half the viscosity of the diethylene glycol solution.

An even more marked difference is shown at lower temperatures . . . at—40°C. a 75 per cent ethylene glycol solution has a 300 centipoises viscosity, as compared with 1000 to 2000 for a 75 per cent diethylene glycol solution.

VISCOSITY OF GLYCOL-WATER MIXTURES



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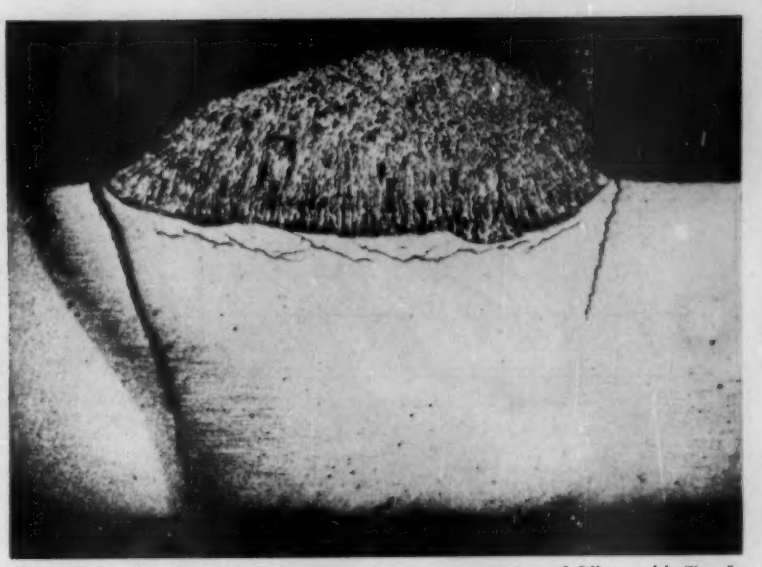
Underbead cracking, bane of welders installing branch connections on a pipeline, under pressure, is being successfully combated by Columbia Gas. Its method:



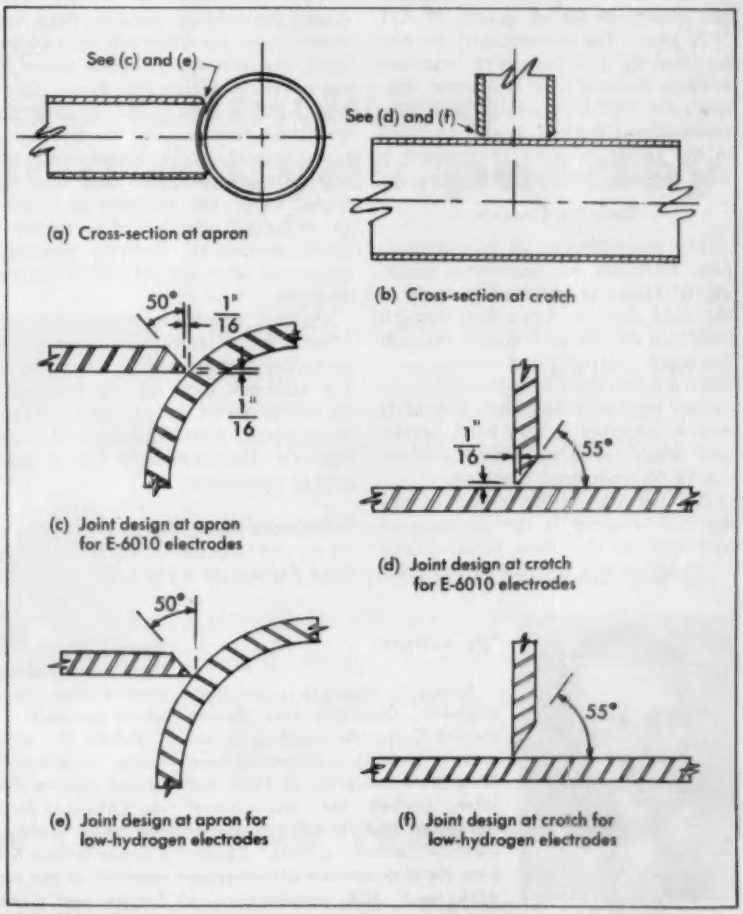
UNDERBEAD CRACKING from bead on plate representative of fillet weld. Fig. 1.

Low-hydrogen electrodes and special joints for hot taps

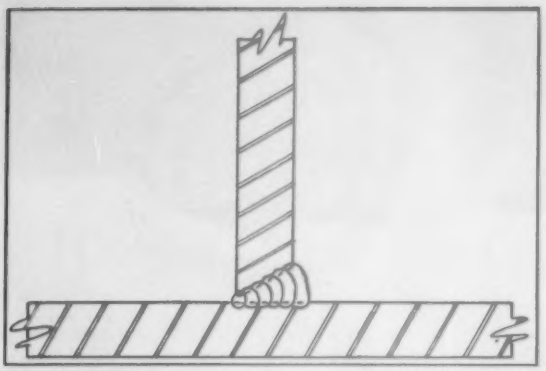
BY ROBERT S. RYAN AND ROBERT R. WRIGHT
Engineers, Columbia Gas System Service Corp.

THE POLICY for installing branch connections on a pipeline under pressure (hot tap) varies considerably. Some companies refuse to make any hot taps; others make only small connections on large-diameter pipelines; some companies reduce the pressure at the time of the fabrication of the hot tap; some companies determine the wall thickness of the carrier pipe at the location where the hot tap is to be made with ultrasonic testing equipment.

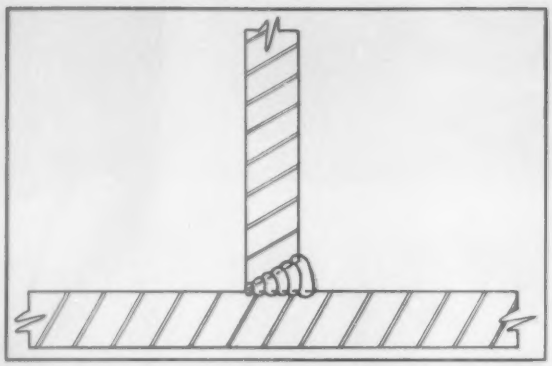
Probably the chief concern in all of these policies is that the welder will burn through the carrier pipe. However, there is another consideration which must be kept in mind when making hot taps, and that is underbead cracking. This phenomenon is associated with entrapment of hydrogen in the weld deposit. An underbead crack typical of those found



JOINT DESIGN for hot taps with standard and low-hydrogen electrodes.



FILLET-WELD cross-section with standard E 6010 electrode. Fig. 3.



FILLET-WELD cross-section with low-hydrogen electrode. Fig. 4.

in hot taps is shown in Fig. 1. Also shown in Fig. 1 is a crack that propagates through the wall thickness, which is an even more detrimental defect.

Primary purpose of this article is to present the basic factors associated with underbead cracking and to describe a welding procedure developed for use in the Columbia Gas System. Essentially, this procedure utilizes a special joint design and low-hydrogen electrodes for all grades of API 5LX pipe. The conventional method for making hot taps with standard E-6010 electrodes is still quite adequate for API 5L grades of pipe. The conventional method is also included in the article in order to compare it with the new welding procedure.

Basis for Concern

The susceptibility of high-strength pipe materials to underbead cracking is related to the heating cycle of the weld deposit. Since high-strength materials are obtained chiefly through increased carbon and manganese, there is a tendency to form martensite in the heat-affected zone. The martensitic structure is very hard, brittle, and notch sensitive, which is conducive to underbead cracking.

Another well-known aspect of underbead cracking is the presence of hydrogen in the weld bead. Some years ago it was found that the principal cause of many of our welding difficulties was the presence of large quantities of hydrogen in the weld metal and heat-affected zone. Hydrogen is a residual element in steel that is always detrimental because it reduces ductility without decreasing strength, causes underbead cracking, and produces delayed fracture at stresses far below the normally anticipated level of failure.

Hydrogen enters the weld deposit during the welding operation from the moisture in the electrode coating or from the atmosphere when there is not adequate shielding of the weld deposit. When the weld deposit is quenched very rapidly, the hydrogen remains in the weld deposit and subsequently diffuses into the heat-affected zone. The presence of hydrogen is further complicated by the very brittle martensitic structure basically associated with the API 5LX grades of pipe.

Preheat, which has been used very effectively in many applications, retards the cooling rate, thereby allowing sufficient time for the hydrogen to diffuse out of the weld deposit and heat-affected zone. This delayed cooling rate also eliminates the formation of martensite.

Fillet welds susceptible . . . Fillet welds which are representative of a weld-bead deposit on a plate, are also susceptible to underbead cracking, as shown in Fig. 1. However, fillet welds are normally not quite as susceptible to underbead cracking as butt welds. Underbead cracking is most predominant in conjunction with the stringer bead of butt welds. Since the stringer bead is small in relation to the large mass of base metal, a very rapid quenching effect takes place.

In a fillet weld, it is possible to make a larger deposit in the first pass which in turn retards the cooling rate. Therefore, this also reduces the susceptibility of underbead cracking in fillet welds. Unfortunately, however, underbead cracking does occur in fillet welds, as shown in Fig. 1.

Research effort has been primarily directed toward reduction of underbead cracking in butt welds because of the very large proportion of butt welds in comparison with the relatively small number of fillet welds. It is readily apparent that preheat could be used quite advantageously for reducing the incidence of underbead cracking. While preheat can be used very effectively in many applications, there are a number of applications where preheat is not practical or feasible, such as a hot tap.

The flow of cool gas in a pipeline almost instantaneously removes any heat in the area around the fabrication for the hot tap. Therefore, one method that has been successful is to

Robert S. Ryan

THE AUTHORS . . .

Robert S. Ryan is supervisory engineer, Columbia Gas System Service Corp. He received a degree in welding engineering from Ohio State University in 1947 and later worked for International Harvester and Batelle Memorial Institute before joining Columbia. He is a member of numerous AGA and ASA committees on welding and piping and is a registered professional engineer in Ohio and Indiana. Ryan holds memberships in several professional societies.

Robert R. Wright is assistant senior engineer, Columbia Gas System Service Corp. Before joining Columbia he was assistant to the chief welding engineer for Chicago Bridge & Iron Co. He is a member of the American Welding Society and a registered professional engineer in Ohio.

Robert Wright

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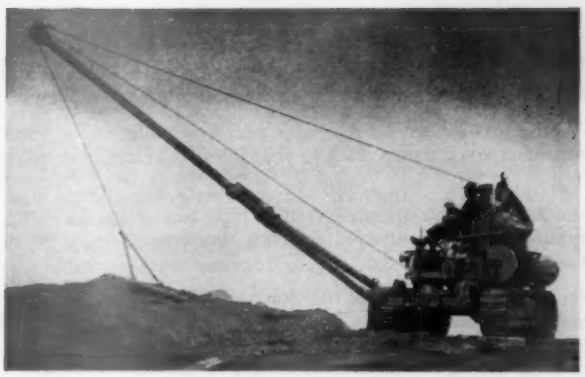

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use an electrode in which the moisture has been removed from the coating. This is referred to commercially as a low-hydrogen electrode.

Welding Procedure

The penetrating characteristics of the **standard E-6010 electrode** makes it possible to produce a full-penetration weld with a joint design, as shown in Figs. 2(c) and 2(d). The resulting weld appears as shown in Fig. 3. We've learned that it is necessary to produce a full-penetration weld of the branch pipe for branch connections. This joint design has proven quite satisfactory through the years. Therefore, every effort was made to produce an equally sound full-penetration weld in the API 5LX grades of pipe when low-hydrogen electrodes became available.

Low-hydrogen electrodes . . . The characteristics of the low-hydrogen electrodes are similar to stainless-steel electrodes but, unfortunately, are quite different from the old faithful E-6010 electrodes. Specifically, the low-hydrogen electrodes have greater tendencies for lack of penetration, slag inclusion, and porosity.

One of the more unusual characteristics of the low-hydrogen electrode is that it is not deep penetrating. Therefore, it was necessary to revise the joint design, as shown in Figs. 2(e) and 2(f). In order to provide for complete penetration, the bevel of the branch pipe must be great enough to allow the electrode to extend far enough into the joint to maintain a short arc. The short arc length is necessary to eliminate porosity.

In addition, increasing the angle of the bevel on the branch pipe enables the electrode to reach down to the root of the joint. This compensates for the shallow penetration of this electrode as well as maintaining a short arc. The bevel found most satisfactory is one varying from 50° in the apron section to 55° in the crotch section.

Many times, upon striking the arc, porosity is encountered during the short time it takes the welder to stabilize the arc and obtain a short arc length. This porosity can be eliminated by striking the arc ahead of the starting point and bringing the arc back to the starting point at which time the arc is stable and there is a short arc length. Welding should then proceed over the point where the arc was struck, thus burning out any porosity which might result from the initial arc strike.

Various welding currents were used during this investigation to determine the optimum current. It was found

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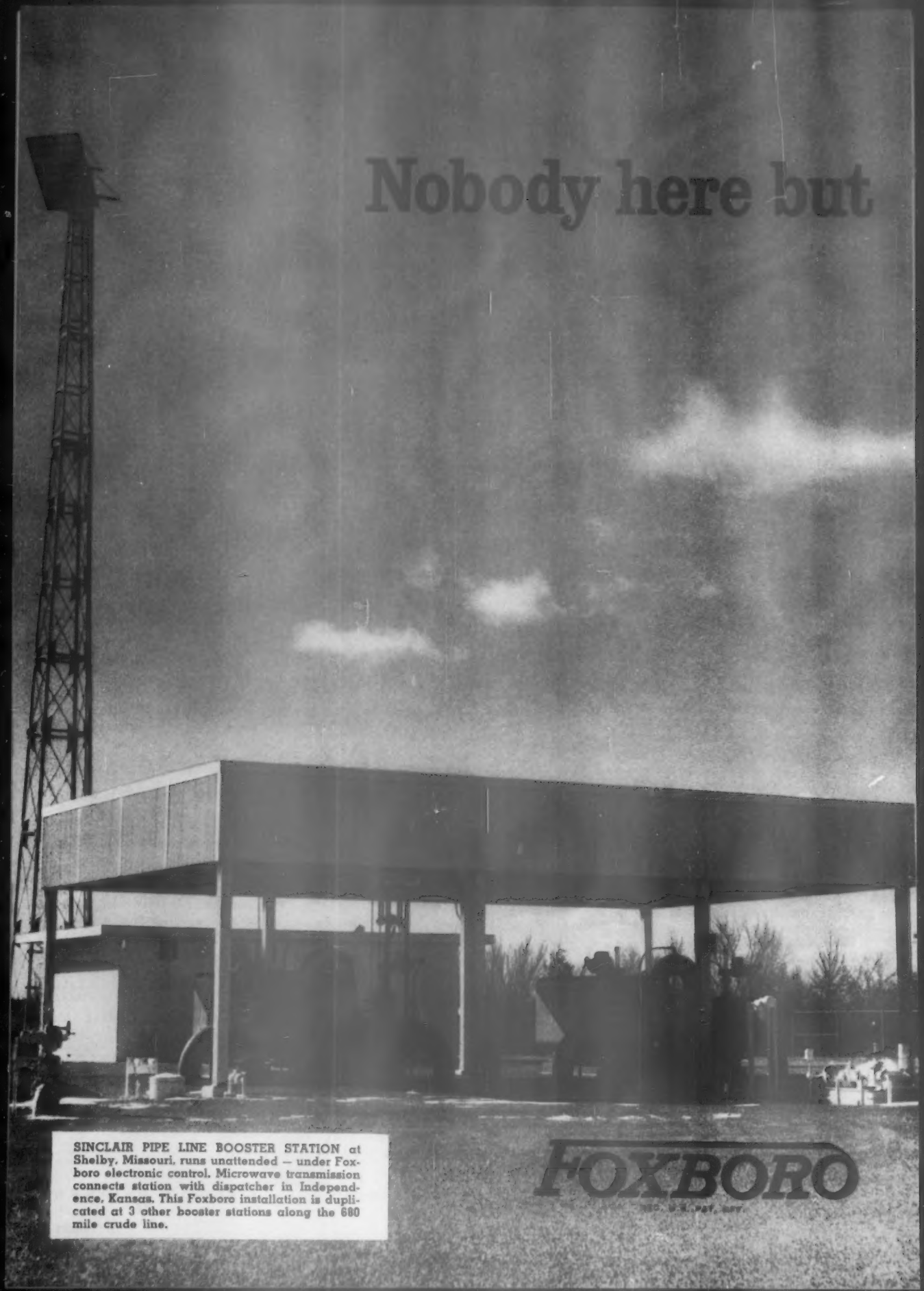


SINCLAIR PIPE LINE BOOSTER STATION at Shelby, Missouri, runs unattended — under Foxboro electronic control. Microwave transmission connects station with dispatcher in Independence, Kansas. This Foxboro installation is duplicated at 3 other booster stations along the 680 mile crude line.

FOXBORO

Foxboro Electronic Control!

Sinclair Pipe Line Booster Stations Run Unattended Since 1957 Start-Up

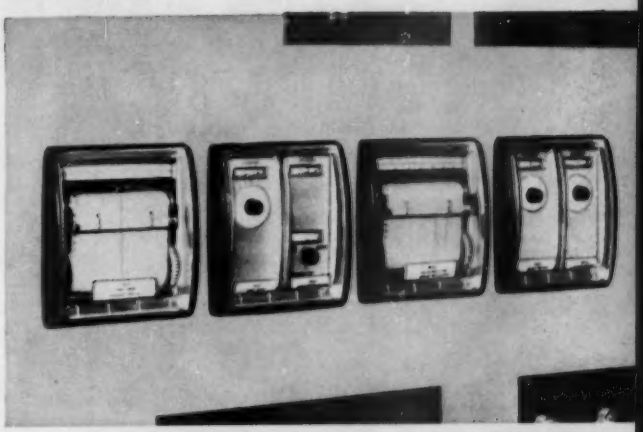
Two years ago, Sinclair Pipe Line Company added four new booster stations to its Cushing-to-Chicago crude line. Stations had to run unattended weeks on end — routine maintenance had to be kept to a bare minimum.

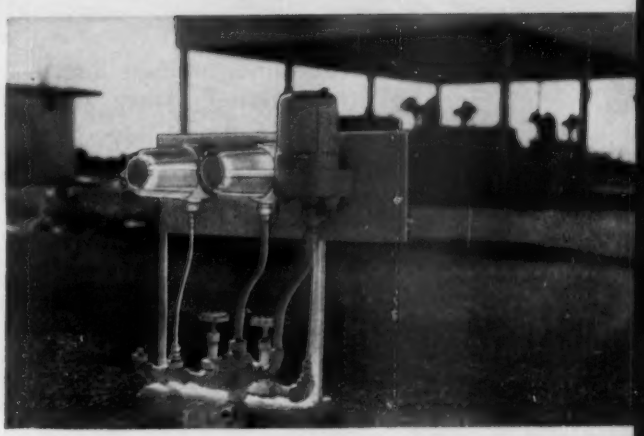
"Foxboro electronic Consotrol* instruments proved an excellent solution," Sinclair engineers report. "We eliminated air compressors, dryers, valve boosters, and other high-maintenance equipment. And we gained the faster control of electronics—important on a crude line as large as ours."

Sinclair's maintenance record shows that Foxboro electronic instruments require practically no attention.

Your operations also may benefit from a specially designed Foxboro electronic Consotrol system. There are instruments for every function in the control loop — all 100% solid state, for greater dependability and least maintenance. Get full details by writing for Bulletin 21-10A. **The Foxboro Company, 609 Neponset Ave., Foxboro, Mass.**

Reg. U. S. Pat. Off.





Top — Foxboro electronic Consotrol instruments for triple auto-selector control of pump suction pressure, discharge pressure, and motor load. System also continuously records these variables on 30-day strip charts. Instruments — checked frequently since November, 1957 — have required practically no attention.

Bottom — Foxboro electronic pressure transmitter (left) delivers high-level d-c signal to control panel. Shown at right is high-limit pressure switch.

electronic Consotrol instrumentation

Warren's High Pressure Screw Pump is proving its true economy with pumping efficiencies of 75% to 85% – on either high or relatively low viscosities

Warren #8CB Screw Pumps handling crude oil at a primary pumping station.

In crude line, product line and refinery jobs Warren High Pressure Screw Pumps —

- develop continuous flow
- can be direct driven . . . speed reduction gears are not necessary
- maintain constant capacity and pressure, even on oil containing foreign matter
- are suitable for unattended stations.

WRITE FOR SELECTION NOMOGRAPH #252

CENTRIFUGAL · SCREW · RECIPROCATING · GEAR

WARREN PUMPS, INC.

WARREN, MASSACHUSETTS

6-1

that the filler beads had to be deposited with a slightly higher current than the stringer bead. Also the angle with which the electrode contacted the work was varied. More reliable results were obtained when the electrode was kept approximately perpendicular to the direction of travel.

During this investigation, both the uphill and downhill methods of welding were examined. With the standard E-6010 electrodes the downhill method has been found to have a number of advantages for pipeline welding. However, there is much more slag involved with the low-hydrogen electrode since it is more fluid than the E-6010 type. Therefore, when downhill welding is used with the low-hydrogen electrode, the slag runs ahead of the arc, thus making it very difficult to obtain 100% penetration.

When welding uphill, the slag runs back away from the arc, thus leaving the root of the weld joint readily accessible to the electrode. For this reason the uphill method is recommended.

Various sequences of depositing the weld beads were used. A wide weaving action is not recommended because porosity often results. It was concluded that the bead method produces a better-quality weld than any other type. The welding groove must be such that the root of the joint is accessible to the electrode. Therefore, in some cases it is necessary to remove high places on various weld beads to obtain this accessibility.

Cleaning was found to be extremely important. Low-hydrogen electrodes are not deep-penetrating electrodes. For this reason, it is necessary to clean each pass very thoroughly because any slag or foreign matter will be entrapped and will not burn out when depositing subsequent passes. Large gas pockets were noted to have emanated from areas of entrapped slag. Therefore, an essential feature which should be emphasized repeatedly is that each pass must be thoroughly cleaned of slag before depositing the next pass.

The pipe surface of the carrier pipe must be clean of rust and scale. It was found that pitted pipe caused a boiling behavior of the weld puddle which increased the incidence of porosity.

The Columbia Gas System has a policy of periodically qualifying the electrodes of various manufacturers. In conformance with this policy, a number of manufacturers' electrodes conforming with the E-6016, E-7016, E-6018, and E-7018 specification were tested. Some were more susceptible to porosity than others. For this

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reason, Columbia maintains an up-to-date list of acceptable electrodes.

Low-hydrogen electrode coatings are made from materials low in hydrogen content with the result that this unstable low-hydrogen state must be maintained by special care. These electrodes when exposed to the atmosphere will absorb moisture rather rapidly. Particular care is taken by the manufacturer in the packaging of these electrodes to seal them from the atmosphere. Therefore the electrodes should be retained in the unbroken carton until used.

Any electrodes exposed to the atmosphere longer than about 4 hours should be heated in an oven to about 200° F. for at least 1 hour to remove the moisture.

Suitable storage devices for handling the low-hydrogen electrodes have been developed. Small storage tubes, made of 4-in. pipe and caps, containing silica gel, can be used for handling the electrodes in the field. A large light bulb in a small box provides sufficient heat to eliminate moisture from the electrodes.

Precautions needed . . . In this investigation, welds were made with electrodes that had been dried in an oven as well as electrodes that had not been dried. Oven-dried electrodes performed slightly better. However, the electrodes that had not been dried had been stored in the laboratory.

In the field, electrodes will not be stored under such ideal conditions and will be much more conducive to absorbing moisture. Therefore, it is recommended that suitable precautions be taken to maintain the low hydrogen content of the electrodes.

Often electrodes when received have small areas of the coating chipped off as a result of handling. Also, the coating occasionally chips from the electrode during welding. When these areas reach the arc, they cause the arc to be very erratic, thus causing and introducing porosity. Therefore, these electrodes should be discarded.

If the coating chips off during welding, the welding should be stopped and the electrode discarded. Certain electrodes are more prone to chipping than others. It was found that those electrodes containing iron powder are more susceptible to chipping than the straight low-hydrogen electrodes.

Acknowledgment

The authors appreciatively acknowledge the contribution made by Charles T. Allen in the development of this welding procedure. His experience and welding skill have helped immeasurably.

Subsurface Exploration with Giant Ripper *saves* *trenching costs*

Upper photo shows method of hard-facing back side of point and adapter. Lower photo illustrates front faces and sides.

STOODY HARD-FACING INCREASES WEAR LIFE 1200%

Crossing the heart of one of California's deserts is an 86 mile stretch of 34" gas line. This area was once riddled with lava flows and eventually overlaid with hard-packed sand. Large ditchers were stopped by the lava beds; explosives could not be economically used until location of each lava flow was determined.

To overcome these difficulties, the contractor designed and built a giant single-tooth ripper. Pulled by a D7 Tractor along the pipe line route at a depth of 5 feet, subsurface conditions were quickly determined. Areas free of lava were then trenched with conventional equipment. Where lava flows were discovered by the ripper, wagon drills prepared the beds for explosives.

The ripper used easily replaceable boot-type points and adapters of mild steel plate. On this job they lasted just two hours. The boots and adapters were subsequently manually hard-faced with cross beads of Coated Tube Stoodite—*stayed in service thereafter for 3 full 8-hour days!*

Stoody Alloys are made in many variations for all wear conditions on all types of equipment... electrodes and rods for manual application with electric arc and acetylene torch—or in continuous wires for semi-automatic and fully automatic welding. For dozens of ways to save money and downtime in your earth-working operations with Stoody hard-facing alloys, ask for free Stoody Guidebook. It's available from any Stoody Dealer (check the Yellow Pages of your phone directory) or write direct.

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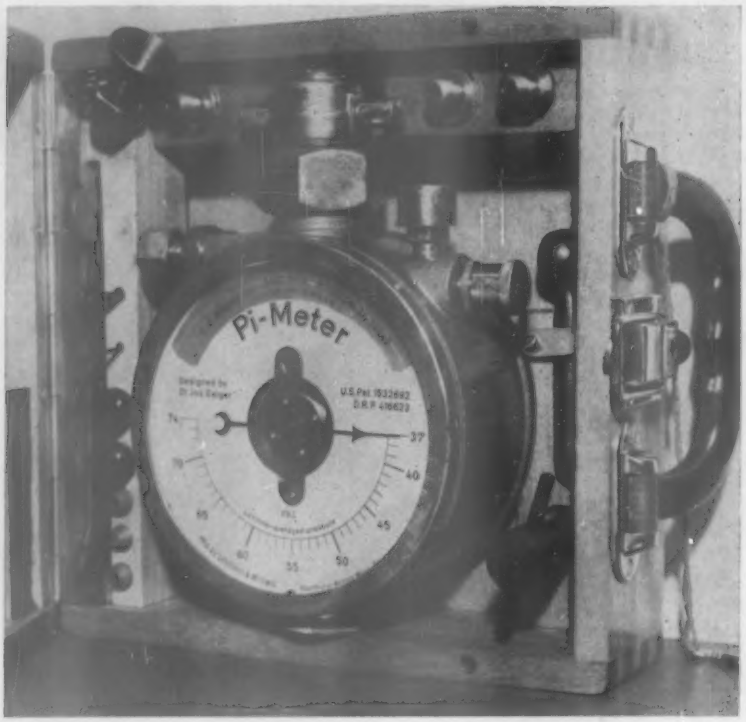
Here's a new tool for obtaining

Proper engine balance



PI-METER indicates mean cylinder pressure. Interpreting results is "as simple as reading the postal scales."

Operators prefer the pi-meter method to the conventional pull card because a better balance is attained in an easier, speedier manner. Better engine balance can be attained only by an eternal vigilance on the part of operators but with the added help of a better "mousetrap" it is felt they can attain their goal much easier. This better balance will pay handsome dividends in the form of fuel savings and also in reducing repair requirements.

BY HUGH E. FISHER
Tennessee Gas Pipeline Co.

OPERATORS of gas-fired compressor engines are constantly looking for a better, more efficient method of keeping engines in proper balance. This is easily understood when it is realized that the cost for fuel constitutes one of the major expense items in compressor-station operation. Probably the most fertile field for an operator to show a reduction in operating cost is in reducing fuel consumption. One of the most important considerations in keeping fuel consumption to a minimum is proper engine balance.

The success of an operator's engine balance is limited by the method he uses for attaining his balance. There are several guides that he may use as an indication (such as temperatures, peak pressures, etc.) but the ultimate is in knowing the actual power being delivered by each cylinder. To realize minimum fuel consumption, it necessarily follows that each cylinder must carry its proportional share of the total engine load. Dr. Jos. Geiger has designed an instrument that he hopes will greatly aid operators in achieving the ultimate in engine balance and has called his instrument the pi-meter.

The pi-meter is essentially a piston-spring type of instrument. The combustion pressure actuates the piston which moves against a calibrated spring. The spring is located as far as possible from the hot combustion gases which helps keep the spring relatively cool. Through a series of gears the movement is transmitted to a main centrifugal mass which in turn is connected to an additional centrifugal mass by means of a spiral spring. The additional mass and spring damp out the oscillations and give a relatively steady position of the pointer.

To properly evaluate his instrument, we must first consider what we would like to have. Some of the more important considerations are as follows:

1. Ease of handling.
2. Interpretation of results.
3. Rapidity with which adjustments can be made.
4. Cool operation on the indicator cock.
5. Accuracy of results.
6. Available record.
7. Cost.

Dr. Geiger's instrument is small and compact but is heavy for its size (about 9¼ lb.). It is easy to drop while moving around on the engines. This problem is not too great since a safety strap can be used to prevent damage if it is dropped.

Interpretation of results . . . The results are very easy to interpret. This is one of the appealing features of the instrument. It is as simple as reading

THE AUTHOR

Hugh E. Fisher is division engineer for Tennessee Gas Pipeline Co. at Middleton, Tenn. He has been with the company since 1950 when he received a BS degree in electrical engineering from Vanderbilt University. He has served as member of compressor-station maintenance crew, plant engineer, research engineer, and station superintendent.

the postal scales. The indicating hand assumes a position on the scale graduated in pounds per square inch. (The foreign model is in kg. per cm^2.) The scale is graduated in 1-lb. increments and the mean pressure of the cylinder is indicated.

Ofttimes (particularly on slow speed two-cycle engines) there is considerable fluctuation of the pointer. Damping can be accomplished by application of oil (such as steam cyclinder oil) to the rim of the centrifugal mass to which the pointer is attached but this has been found to be unnecessary in most cases. In fact, it is usually undesirable since damping will make the instrument ignore cylinder miss which could easily lead to poor engine balance. Experience has shown that in most applications good operators will achieve better balance without damping since excessive oscillations can usually be eliminated by proper adjustments on fuel, ignition, or air.

It is sometimes desirable to pinch the indicator cock to steady the reading but this must be done with care because it could lead to false readings. Some claims are made that the actual horsepower can be obtained with the pi-meter. Experience has shown this to be somewhat misleading. It is felt that this might be done in the future by extensive tests and comparison with more elaborate balanced pressure indicators. Presently, it is doubtful that the accuracy realized would be of much value to the operator.

Balance adjustments . . . Another very appealing feature of the instrument is that adjustments for engine balance can be made while the instrument is reading which makes for a speedier balance. This is a vast improvement over some of the more commonly used indicators where adjustments had to be made, another sampling made to note the change, and then corrections made.

Cooling . . . The instrument operates much cooler than most other instruments used for indicating. Connections are provided for cooling so that either cool compressed air or water can be circulated. Facilities are also available for water to percolate for cooling. While these features would be desirable for continuous service, normal usage does not require added cooling.

Accuracy of results . . . The results obtained are very satisfactory in getting proper engine balance. It has been found to be superior to the peak-pressure method. Peak pressures can sometimes be very inaccurate. Peak pressures do not necessarily show true power of a cylinder. For instance, if one cylinder has earlier ignition than another, its peak pressure will be higher when in reality the power developed by that cylinder may be lower. Conversely, late ignition may show low peaks when the cylinder actually is in an overloaded condition. It is in this field that the instrument shows particular merit.

One particular engine was found that would not operate at rated speed. An investigation of peak pressures showed the engine to be in acceptable balance. The pi-meter showed one cylinder to have a low mean pressure. By bringing this low mean pressure up to the average, the engine carried its load satisfactorily. Investigation of some V-type engines shows that one side is constantly balanced low by peak-pressure method.

One interesting feature is the fact that it is impossible to adequately balance some particular engines with the conventional pull card. This condition is caused by apparent detonating strokes which cause such sudden shock to the peak-pressure measuring instrument that it will destroy the indicator. It has been proved by more elaborate instruments that the cylinders were not actually detonating. But since there is little or no power in detonation, the pi-meter ignores it. It has proved to be a simple matter to adequately balance these engines with the pi-meter.

Available record . . . The greatest objection to the pi-meter is the fact that there is no record available other than readings taken by operators. Some supervisory personnel desire to have a card to observe. None is available with the pi-meter. Neither are individual strokes separated and in some instances, it is desired to observe each stroke. For this type of observation other types of indicators must be used.

Cost . . . The initial cost of the instrument is comparable to other types of instruments doing the same job. It is very rugged and will take rather severe punishment. It is felt that the repair costs will be low since the working parts are few and are made of materials which should give long life.

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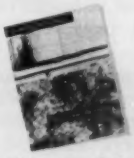

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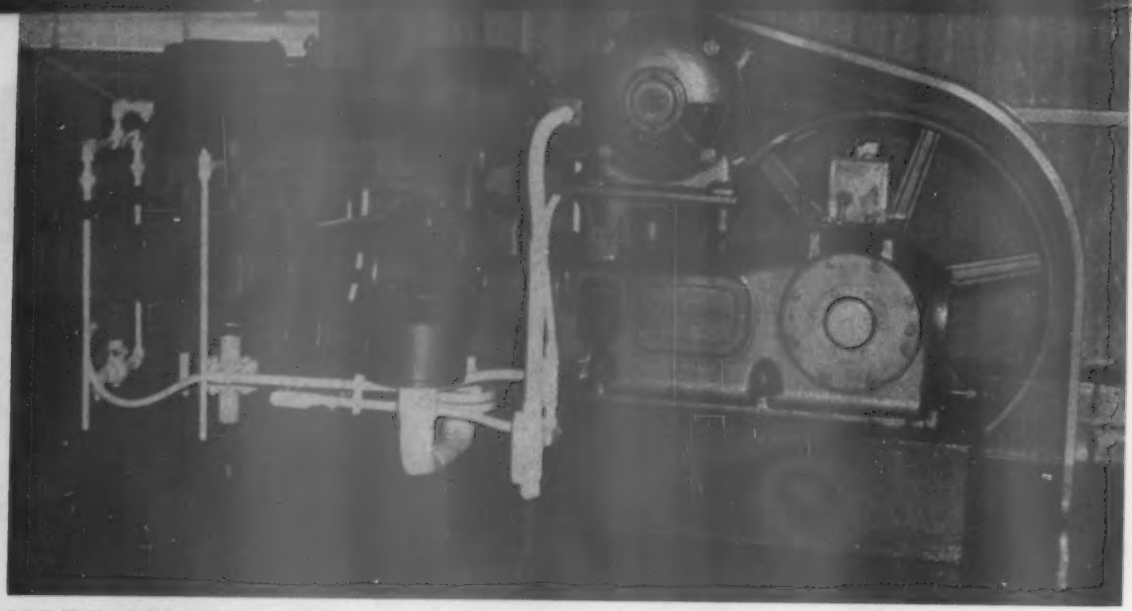


SYNTHETIC LUBRICANTS are used exclusively in this air compressor in the compressor cylinders. Tray under lubricator box prevents fluid drip or spillage from removing paint from the compressor crankcase.

What Trunkline has learned about

Compressor-station lubrication

BY CECIL R. CARTER
Supt., Compressor Department
Trunkline Gas Co.

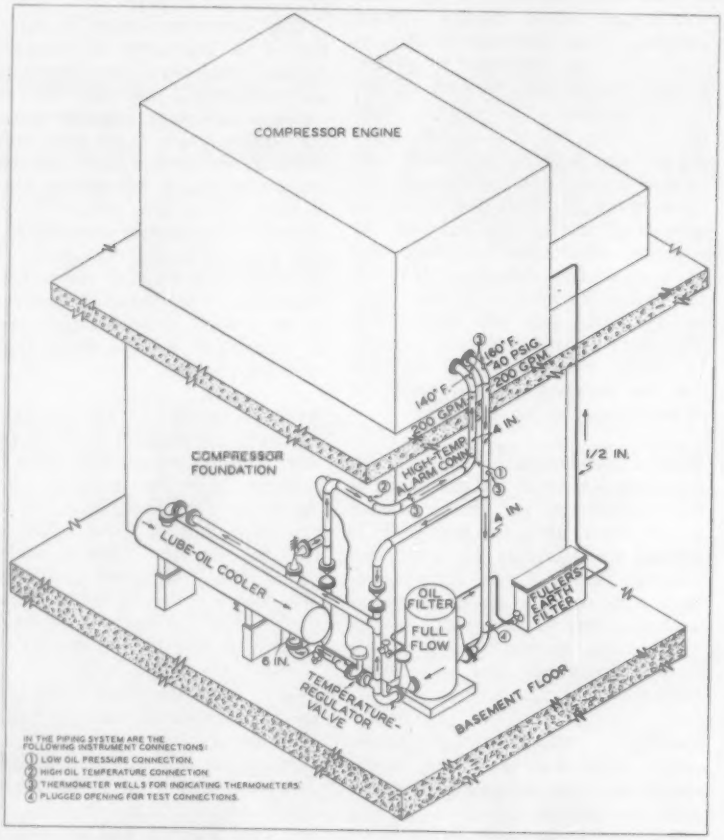
LUBRICATION of compressor-station equipment has for many years demanded the constant effort of operators and lubrication personnel to evaluate and determine the advantages and disadvantages of various available lubricants.

Here are the experiences of one gas-transmission company in compressor-lubrication problems and subsequent effects of the results upon maintenance and operational procedures. We make no claim to having completely solved the problems herein. Our conclusions on types of oil, oil filtration, centrifugal oil cleaning, synthetic lubricants for starting-air compressors, nonlubricated packing, aluminum bearings, etc., are based on test results that have indicated an advancement toward improved operations.

These conclusions should not be interpreted as proved facts. Often a very small variable in conditions can seriously alter results; therefore, the solution for our problems would not necessarily be the answer for others.

Lubricating Four-Cycle Engines

In a 1955 construction program, our company built eight new compressor stations. Six of these were



TYPICAL LUBE-OIL system is shown in isometric diagram.

How to purchase heads economically

A number of suggestions that may help you to reduce costs are contained in our new folder "Pertinent Facts on Purchasing Flanged and Dished Heads." Factors that govern the price of heads are described, and a list of the required data for orders and inquiries is included. Ordering from the stock sizes at Sparrows Point may save you time and money, and a full list is contained in the folder. A copy is yours for the asking at any Bethlehem sales office.

Bethlehem makes flanged-and-dished heads to meet virtually every requirement: ASME Code, elliptical and standard flanged-and-dished. Also flanged-only, dished-only, shallow-dished, double-dished, and heads for special requirements.

Bethlehem heads are available in diameters up to 144-in.—and in thicknesses from 14 gage to 2½-in. We also produce standard manhole and hand-hole saddles, covers and fittings, as well as heads with flued openings. A number of sizes of ASME Code flanged-and-dished heads are stocked for prompt delivery.

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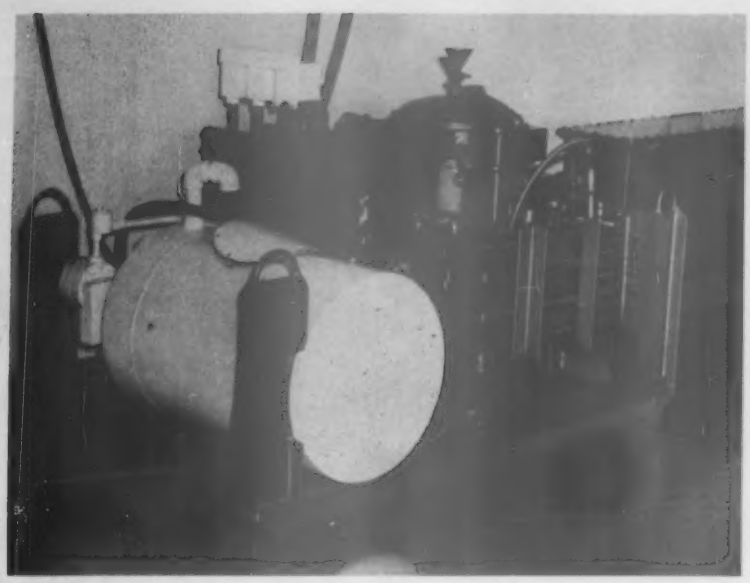
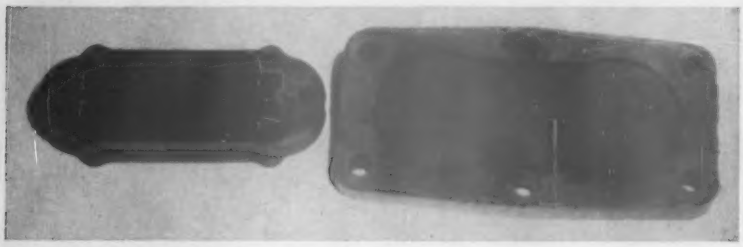


CENTRIFUGE, normally stationary mounted, has been skid mounted in the field. Mounting is sized to fit pickup truck for ready transport to any location.



COMPRESSOR VALVE and cover have operated intermittently for 4 years without cleaning.

powered with reciprocating gas engines and two with gas-fired turbines. The new reciprocating engines were of the four-stroke-cycle type, whereas prior to this time, we had been using the two-stroke-cycle engines.

Realizing that it would be more difficult to maintain oil stability in four-cycle engines, we planned what we thought would be a good lubrication program. We hoped to use a good grade solvent-extracted paraffin-base straight mineral oil with full-flow filtration plus an earth-type bypass filter on each unit. The full flow was to remove the solids and the fuller's earth to maintain low acidity or neutralization number.

We immediately met with opposition from the engine manufacturer that was to supply the engines for four of the six stations. This manufacturer insisted upon a heavy-duty detergent-type oil. The other engine manufacturer left the oil selection to us, specifying only that we use a good grade of oil. Since this was our first experience with these particular engines, we readily complied with the first manufacturer's request; however, on the remaining two stations of identical size and equipment, for the purpose of comparison, we lubricated one as we had originally planned with a straight mineral oil and the other with a heavy-duty detergent oil.

Lube-oil comparisons . . . The results of this comparison were so definitely in favor of the straight mineral oil that we soon changed to this type of oil in several of our other four-cycle-engine stations. Much to our disappointment, we soon learned that the results of our first comparison were not necessarily indicative of the results we could expect from other oils of either type. While we did not have any serious problems following changes in straight mineral oils, it was quite evident in most cases that the detergent oils performed best. Consequently, most of the stations were returned to detergent oils.

Since all the stations involved in this change were lubricated by different oil companies, it should be definitely understood that these comparisons were not on the same products, but only on the same type of product.

Contrary to the usual pattern, however, one of our most impressive lubrication records on four-cycle engines has been accomplished with a solvent-refined paraffin-base straight mineral oil.

In our opinion, all oils have some application for which they are suited; therefore, we must assume there are really no bad oils. Only the application can be bad. We do not believe that the mere fact an oil is detergent or straight mineral should be the determining factor for its application. Our experience indicates that for four-cycle-engine service, some straight mineral oils are superior to some detergent oils, but usually when both oils are refined to the specifications of the same oil company, the detergent oils give better results.

Filtration Practices

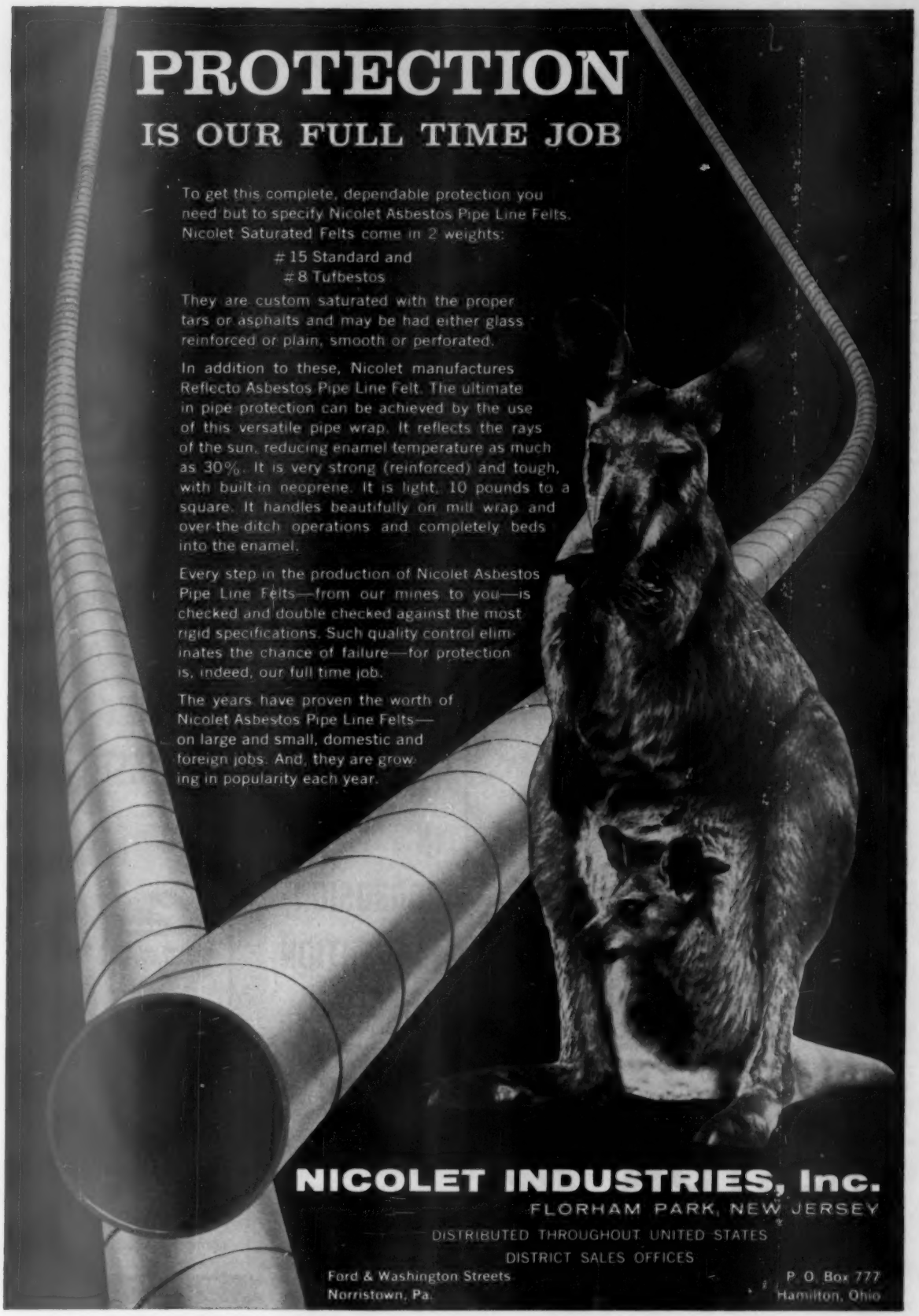
The useful life of crankcase oils, as well as the life of the equipment they serve, depends greatly upon the oil maintenance. Our use of full-flow filters on all compressor engines with the addition of fuller's earth bypass filters at several stations has given very satisfactory results.

Seven of our ten reciprocating-engine stations are also equipped with oil centrifuges, five of which are skid-mounted to make them available to any other station location on very short notice should they be needed. Use of the centrifuge greatly prolongs the life of the full-flow filter elements, especially on the four-cycle engines which normally contaminate the oil

THE AUTHOR

CECIL R. CARTER

. . . is compressor department superintendent for Trunkline Gas Co. He has been in gas pipelining 34 years. He joined Panhandle Eastern in 1925 and served successively as laborer, operator, assistant plant superintendent, plant superintendent, and division superintendent. Carter left Panhandle in 1953 when he assumed his present position with Trunkline.


PROTECTION
IS OUR FULL TIME JOB
To get this complete, dependable protection you need but to specify Nicolet Asbestos Pipe Line Felts. Nicolet Saturated Felts come in 2 weights:
15 Standard and
8 Tufbestos
They are custom saturated with the proper tars or asphalts and may be had either glass reinforced or plain, smooth or perforated.
In addition to these, Nicolet manufactures Reflecto Asbestos Pipe Line Felt. The ultimate in pipe protection can be achieved by the use of this versatile pipe wrap. It reflects the rays of the sun, reducing enamel temperature as much as 30%. It is very strong (reinforced) and tough, with built-in neoprene. It is light, 10 pounds to a square. It handles beautifully on mill wrap and over-the-ditch operations and completely beds into the enamel.
Every step in the production of Nicolet Asbestos Pipe Line Felts—from our mines to you—is checked and double checked against the most rigid specifications. Such quality control eliminates the chance of failure—for protection is, indeed, our full time job.
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3-inch and 5-inch diameter heads . . . back and bottom connected models with rotatable scales . . . ranges cover an area from —100° to 1000° F. or —100° to 500° C. . . . stems up to 72" available.

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ALUMINUM BEARING break is attributed to defective material and excessive clearance. There was no damage to the bearing journal.

at a much faster rate than the two-cycle units. These centrifugal machines are also very good for removing water from straight mineral oils if the need should occur.

Until recently, our full-flow filtering was limited to about 18 or 20 μ with the use of sock and stacked-disk-type throwaway elements. After some discussion with several lubrication engineers, we concluded that much better results would be attained if we could filter to a maximum of about 5 μ.

To do this, we first tried elements of greater density but found the pressure drop across the filters to be excessive. This created the problem of increasing the filter-case size or finding elements for the existing cases which would give the desired filtration without restricting the flow. The logical solution at this point seemed to be pleated-paper filter elements which, due to their construction, have a much greater surface area per element.

Filter tests . . . For our first test, we used a paper which filtered to 1 μ. In the first 7 hours of operation the pressure buildup across the filter reached approximately 20 psi. and the elements were then changed. The next set of elements lasted about 3 days and the third set about 2 weeks.

The color of the oil at this time was visually improved and blotter tests indicated great improvement in solids removal. The life of the elements increased quite rapidly up to about 1,800 hours per set on the 1-μ elements. We are now of the opinion that 5-μ filtration would be ample and that we should expect at least 3,000 hours' filter element life under normal operating conditions.

Our decision to use pleated-paper filtration has not been and is not yet without problems. Three suppliers were found who could furnish pleated-paper elements that would fit some of the various sizes, shapes, and lengths required by our existing filter cases. (We have not been able to fit all cases at this time.)

Among the products of the three suppliers, we found some in which the paper was of poor quality or insufficiently treated and would rupture in the pleat folds after a few hours' operation. We also found some in which the element case or jacket would collapse or poor workmanship would allow the element to come apart. Two of the suppliers have shown real interest in working with us in improving their product and their elements are now doing an excellent job.

Several filter companies that do not now manufacture the pleated-paper element have expressed interest in developing this type of element if the demand will justify the conversion or addition to their present lines.

Filtering detergent oils . . . Earth-type filters, of course, present a problem with detergent oils since they remove the detergents as well as corrosive acids in the oil. We have and still do use fuller's earth filtration on some detergent oils. While this is not recognized as good practice, we believe that with some oil and under some conditions we do derive considerable benefit.

The results of this type of filtration seems to vary somewhat among oils, depending upon the type and amount of additive. Some have expressed the idea that while oil additives are immediately retained by earth filters, they are later released, as harmful contaminates are adsorbed and replace them in the filter. We have no indication as whether or not this might be true. It is quite evident, though, that the acidity of straight mineral oils can be well controlled by use of fuller's earth filtration.

Supplier recommendations . . . Our next concern is one which I believe might well be a problem of all quantity users of oil who depend upon the recommendations of various oil-company suppliers based on their laboratory tests. Our concern is the lack of test standardization and uniformity in analysis significance. We as customers of 10 different oil companies find it impossible to coordinate the various analyses and recommendations. Especially do we find ourselves puzzled by the latitude in the significance attached to the neutralization number of oils in service.

For example, according to our information, the acid or neutralization number of an oil is the weight in milligrams of potassium hydroxide required to neutralize 1 g. of the oil. This number expresses the total amount of the mineral acid and of the organic compounds having acid characteristics.

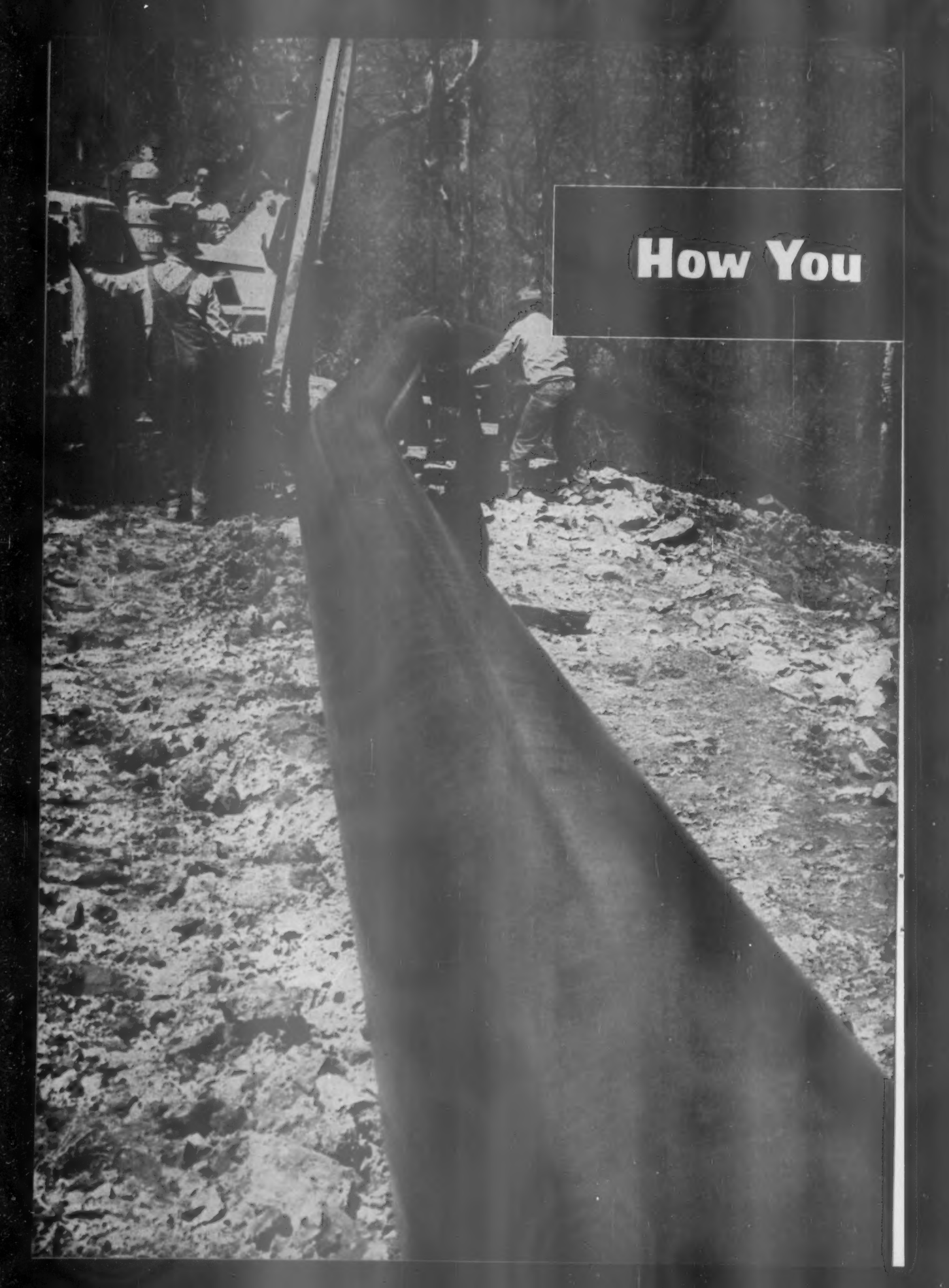
The neutralization number given on an analysis is a total of acids and compounds with acid characteristics, some corrosive and some noncorrosive. Therefore, how can an intelligent recommendation for an oil change be made when the percentage of the total acid content that is corrosive to the engine metal has not been determined?

Until we can obtain some uniformity in the answer to this question and a closer standardization of analysis and test significance, it is our opinion that the customer will find it advantageous, in many cases, to make his own evaluation of recommenations regarding his crankcase oils.

Synthetic Lubes for Starting Air Compressors

Not many years ago explosions of starting-air lines were more or less a common occurrence. There have been many good articles written on the cause of such explosions. The severity and hazards involved are general knowledge to most compressor-station personnel. We will not relate the cause and effect of such explosions, but we now believe a solution to the problem can be found in the use of synthetic fire-resistant lubricants for air compressors.

Five years ago we made our first test of synthetic lubricants in air-compressor service. The compressor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had been in service approximately 3 years using conventional oils prior to the time of the test. The compressor was a two-stage horizontal type driven with an electric motor, automatically pressure controlled, pumping from atmosphere to 250 psi.

We were advised that the synthetic lubricant was not compatible with the petroleum oils, so our first step was to completely disassemble and clean the compressor. Pistons, piston rods, cylinders, and piston rings were then measured and the compressor was reassembled. Lubricator feeds rates were increased about 50% to assure ample lubrication.

After starting the unit, we had some difficulty with dirt in the second-stage compressor valves and stoppage in the discharge-line filter. This was caused by carbonaceous residue from the interstage cooler and from the compressor discharge line which we had not cleaned. The synthetic lubricant immediately stripped all residue, including paint, to the bare metal.

As soon as the loosened particles were removed from the valves and filters, no further difficulty was experienced. After a few weeks' operation, and periodically thereafter for about a year, the compressor was dismantled for inspection to determine any excessive wear or other objectionable features.

These repeated inspections revealed no excessive wear and the rate of lubrication was reduced gradually to approximately the same as it had been with the conventional oils. We believe there are two very outstanding reasons for using synthetic lubricants in starting air compressors. First and most important is elimination of the explosion hazard and the second is the cleanliness maintained in the air system. It is no longer necessary to clean valves, coolers, etc., because of carbon or other residue deposits.

The only penalty is the cost of the product which is approximately seven times that of the conventional oils. Considering the small amounts used in this type of service, the difference in cost can still be considered inexpensive insurance against the dangerous explosion hazards. We are also lubricating several V-type, two-stage air compressors in which the crankcase is lubricated with the synthetic lubricant, the only difference being that the crankcase lubricant is of slightly higher viscosity. This service has also been entirely satisfactory.

Nonlubricated Packing

We have also conducted some tests with molybdenum disulfide impregnated packing, commonly called the nonlubricated packing.

Our first test was a set of packing for a 4-in. compressor rod with the compressor operating pressure of about 900 psi. Upon installation the packing was lubricated for the first 2 days and then the lubricator feeds were shut off. The only lubrication after that time was from the possible atomizing of the compressor-cylinder lubricants.

Periodic checking of the rod gave no indication of excessive wear and the operation was very satisfactory for approximately 8,000 hours. At this time, a dehydrator failed on one of our gas-supply lines, allowing water to pass through the line in quantities sufficient to overtax drips and scrubbers, and consequently passing some through our compressors. Upon contact with the water, the binder agent in the packing seemed to deteriorate to the extent of permitting lamination, thereby allowing the gas pressure to expand the packing in the case and leaving it unfit for further service.

Following this test, two more sets of the same brand of packing were tried, one set in the same station and one set in another station. Both sets

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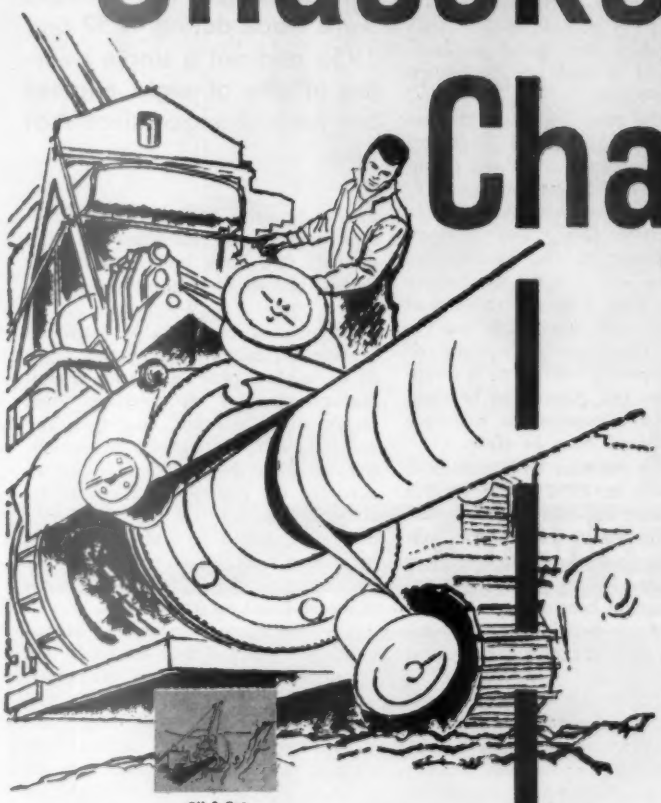

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operated only a very short time until they, too, laminated and had to be removed from service. During the time of these tests we also tried a set of the same type of packing from another vendor. This set also laminated, but was replaced by the vendor with a second set which is still operating satisfactorily after 8,000 hours. The results of our tests would indicate this type of packing to be entirely feasible with a very good potential, provided the problem of lamination can be overcome.

Within the past few years the use of aluminum bearings in large gas engines has become increasingly prominent, yet many operators hesitate to use them, feeling that they require special care in fitting and in operation compared to the babbitt and trimetal bearings. We do not believe this to be true. Other than normal bearing care and adjustment, we believe that the only prerequisite of aluminum bearing operations is cleanliness of the oil. Aluminum bearings do not have a comparable tolerance for dirt—*the oil must be clean.*

Our first experience with aluminum bearings was in 1952. Prior to this time, we were experiencing considerable difficulty with lead-base babbitt bearings in several 160-hp. engines used in generator service. The necessity for frequent bearing replacements brought about a decision to try aluminum bearings. The changes were made during 1952 and 1953 and not a single bearing in any of eight engines has been changed since that time.

In our 1955 expansion program, seven of the large compressor engines purchased were equipped with aluminum bearings. As seems to be the common practice, most of these bearings had clearances considerably in excess of that normally required for babbitt or trimetal bearings. This condition necessarily required larger oil pumps in order to maintain oil pressures. Strangely enough the only trouble we had with these bearings we attribute to excessive clearances.

One set of main bearings was found to have 0.018 to 0.020-in. clearance and the shells were loose in the bearing caps and frame base recesses. The crank bearings on the engine appeared to be well fitted and since changing the main bearings we've had no trouble. On the units furnished by another manufacturer, some of the crank bearings developed breaks. These breaks were mostly along the shell flange and no damage occurred to the crankshaft journals.

After some discussion with this manufacturer, we were furnished two test sets of crank bearings with clearances comparable to conventional

"Our first experience with aluminum bearings was in 1952 . . . prior to this the necessity for frequent bearing replacements brought about a decision to try aluminum bearings. The changes were made during 1952 and 1953 and not a single bearing in any of eight engines has been changed since that time."

babbitt bearings. One set was a fixed-type bearing and the other was full floating. We have had no difficulty with either set of these close-fit bearings.

Because of considerable crank-pin bearing difficulty on still another make of engine, we proposed to the manufacturer that we try converting one engine to aluminum bearings. The manufacturer, through its representative, agreed to the change, provided we accepted the common practice of increasing the size of the circulating oil pump, install an additional pump to pressurize oil lines prior to startup, and increase bearing clearances to a range of 0.011 to 0.014 in.

Considering our previous experience, we believed that it should not be necessary to increase the clearances above 0.008 or 0.009 in. And that by maintaining such clearances it also would not be necessary to change the oil pump. (This was on a 12-in. crankshaft.) Accordingly we ordered a set of low-clearance bearings but no additional circulating oil pump. We did install a small hand-operated pump to pressurize the oil lines before starting the engine.

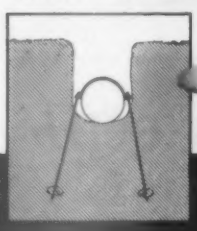
In order to reassure ourselves, we installed one bearing with a clearance of 0.008 in. and ran the engine for about 10 days under various speed and load conditions. The engine was then shut down and the bearing was removed for visual inspection. The appearance was so good that we immediately installed the remainder of the set. Clearances varied from 0.006 to 0.009 in.

There was no noticeable change in oil pressure. At the time of this writing, this set of bearings had been in operation for slightly more than 3 months. Two visual inspection again reassured us that we need not expect difficulty due to clearances and that with the low clearances the existing oil pump is adequate. For the use of aluminum bearings, our emphasis is still on keeping the oil clean.

Cut Costs with Chance PIPELINE Anchors

Crew installing Chance Anchor for United Gas Pipeline Company in Louisiana.

Cut-away view of anchor and bracket installed in trench.



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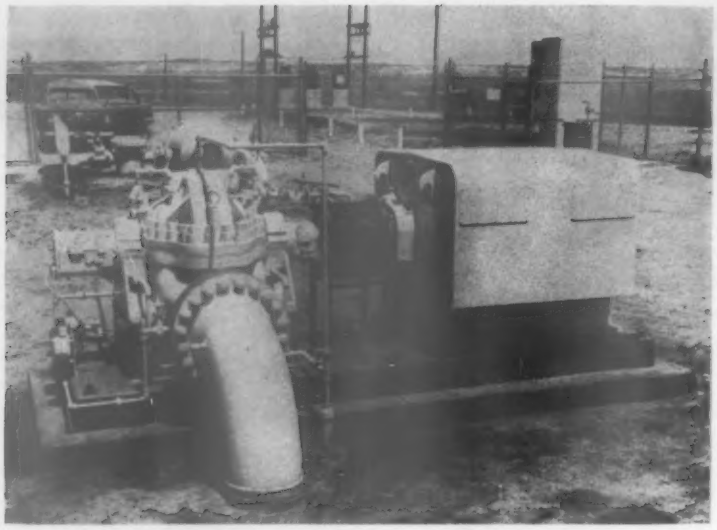


ADVANCES EXEMPLIFIED in this installation include spacer coupling, self-aligning sleeve bearings, and weatherproof electric motor.

Better tools for better pipeline upkeep

as reviewed by

ALVA C. SMITH

. . . senior mechanical engineer for Mid-Continent Pipe Line Co., Tulsa. He joined the company 15 years ago, and during that time he has served as foreman of mechanical maintenance and superintendent of mechanical maintenance and construction. He was graduated from Oklahoma State University in 1935 with a BS in civil engineering, and also holds degrees from the International Correspondence School.

CREATIVE THINKING is today's most prized profit-producing possession, and pipeline-maintenance personnel in general have a widespread and enviable record of achievement. Some of the most important developments will be cited here and their significance pointed out in terms of job performance and over-all industry welfare.

Mechanical Seals

During the early stages of World War II, the author experienced some of the pump "packing troubles" which placed severe limitations on pipeline operations as late as 1949. About 1944, low-pressure-type mechanical pump seals were undergoing development, with limited success. Maintenance personnel were generally convinced the idea could be perfected, pending overcoming some design defects.

In 1946 Plantation Pipe Line set up an experimental station to study service life and economic operation of pump mechanical seals. The results were so encouraging that a program was started in 1949 to install mechanical seals in all of the 10-in. and 12-in. main line pumps. These seals operated more than 15,000 hours and were still in good operating condition when inspected.

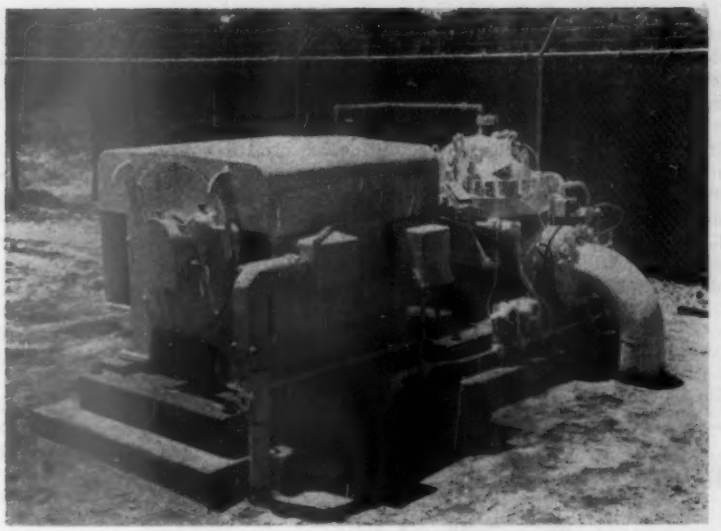
Simultaneously, a number of crude-oil pipelines were testing mechanical seals in crude-oil pumps. Similar results were obtained in crude service, and subsequent experience has proven the reliability of the mechanical seal. As a result of the excellent performance obtained by these mechanical-seal trial tests, all centrifugal pumps are now available from the manufacturer with mechanical seals, if specified.

The significance of this development is not merely a better type of packing alone, but the final removal of the most stubborn maintenance barrier on the road to remote station operation.

Successful development of pump mechanical seals also removed a real barrier to more extensive use of centrifugal pumps. The result has been increasingly widespread use of centrifugal pumps with considerable cost reduction to the industry.

Spacer coupling . . . Widespread use of centrifugal pumps soon pointed up another need — that of improved motor-to-pump coupling. Consequently, the spacer coupling was developed to its present state and immediately accepted by the industry.

As a result you can remove the pump inboard radial bearing, bearing housing, and mechanical seal without the tremendous job of removing the pump head to repair the radial bearing or mechanical seal. These spacers are



SAFETY CONTROL devices have an important part in the successful operation of unattended pumping units such as this.

"Safety devices play an important part in any modern maintenance program . . . To keep competitive, equipment placed in service today must be purchased with accessories and protective devices which will insure continued and extended operation while unattended. Careful selection of safety devices will assure high returns on . . . investment."

effective for reducing down time and expense. Thus a maintenance barrier has been permanently removed, and repetitive cost reduction assured.

Self-Aligning Babbitt Sleeve Bearings

The problem of motor-bearing failures was now the remaining barrier to unattended operation. A new line of motors with the distinctive feature of having a new-type small self-aligning babbitt sleeve bearing has almost eliminated this maintenance barrier.

These self-aligning bearings are much smaller than the type used on the older line of motors, and maintenance is simplified in that bearing repairs can be made with little down time. These bearings are lubricated by an oil ring and require a higher-viscosity oil than friction bearings. Reports indicate these bearings are very satisfactory; thus an important barrier to unattended operation of motors has been removed.

Automatic Oil-Level Controllers

Development of the automatic oil-level controller removed the most stubborn maintenance barrier to unattended operation of the internal-combustion engine. There are numerous devices for oil-level control, most of which insure a continuous supply of oil to the crankcase and maintain a constant oil level.

These controllers almost eliminated failures attributable to inadequate oil supply. Several of these devices permit lowering the operating oil level. The low oil level reduces frothing, splash, pressure on bearings, and excess loss of vapors through the breather. Long-period test by Mid-Continent on many engines shows the practice will reduce oil consumption from 50 to 55% consistently.

Low-cost operation and maintenance of machinery depends more on correct lubrication than any other factor. Thus, the automatic oil-level regulator has become the foremost development of the past 25 years, related to the low-cost maintenance and operation of internal-combustion engines.

The potential operating-labor saving made possible by this development is even more significant. Experience has

Table 1—Relative Importance of Thin-Wall Pipe as Related to Steel Cost

O.D. (in.)	Wall thickness (in.)	Pounds per ft.	Tons per mile	Cost per mile	Cost per 1,000 B/D capacity*
4½	0.156	7.25	19.14	$3,830	$29,800
4½	0.188	8.64	22.81	4,712	36,800
4½	0.219	10.00	26.40	5,280	41,200
4½	0.237	†10.79	28.49	5,652	44,000
6⅝	0.188	12.89	34.03	7,014	18,200
6⅝	0.219	14.97	39.52	7,966	20,650
6⅝	0.250	17.02	44.93	8,885	23,000
6⅝	0.280	†18.97	50.08	9,725	25,200
8⅝	0.188	16.90	44.62	9,125	12,250
8⅝	0.203	18.27	48.23	9,658	12,900
8⅝	0.219	19.64	51.85	10,375	13,950
8⅝	0.250	22.36	59.03	11,560	15,550
8⅝	0.277	†24.70	65.21	12,697	17,000
8⅝	0.312	27.74	73.23	13,930	18,750
8⅝	0.322	†28.55	75.35	14,206	19,150
10¾	0.203	22.88	60.40	12,461	8,150
10¾	0.219	24.60	64.94	13,280	8,700
10¾	0.250	28.04	74.03	14,860	9,700
10¾	0.279	†31.20	82.37	16,410	10,700
10¾	0.307	†34.24	90.39	17,720	11,600
12¾	0.219	29.28	77.30	16,305	3,160
12¾	0.250	33.38	88.12	18,375	3,540
12¾	0.281	37.85	98.87	20,240	3,900
12¾	0.312	41.51	109.59	22,240	4,280
12¾	0.330	†43.77	115.55	23,310	4,480
12¾	0.344	45.55	120.25	23,845	4,600
12¾	0.375	†49.56	130.84	25,600	4,925
16	0.250	42.05	111.01	23,065	1,358
16	0.281	47.22	124.66	25,670	1,697
16	0.312	52.36	138.23	27,890	2,045
16	0.344	57.48	151.75	30,310	2,444
16	0.375	62.58	165.21	31,845	2,790

*Length of line 35 miles—800 psi. operating pressure.
†Standard-weight pipe.

proven it to be low-cost maintenance insurance, providing practically trouble-free operation. The conditions under which engines are being operated 30,000 to 50,000 hours between overhauls are largely attributable to the oil-level controller.

Vibra Switch

Vibration is energy diverted from a useful purpose to a destructive end. Serious maintenance problems arise from this source. Various types of mechanical vibration constitute the most stubborn remaining barrier to unattended operation.

Probably some of the most important developments in the past 6 years have originated in this area of endeavor. The vibra switch is typical of the protective devices now available to prevent vibration damage. This instrument detects mechanical vibration. It may be set to shut down motors or engines at a preset level of vibration. The author's experience with this device has been very encouraging. Thus another barrier to unattended operation has been bypassed.

Desurgers

Pulsation and pressure surge has long been a serious barrier to pipeline operators, and the root cause of serious maintenance problems. Pulsation is not a mere maintenance problem, but a source of risk from which disastrous losses have resulted. It can adversely affect profit and loss sheets.

Pressure surge is essentially the reaction due to changes in the velocity of fluid flowing through a pipeline. It occurs most frequently, and with greatest intensity, when reciprocating pumps or compressors are connected to main transmission lines through piping manifolds which produce frequent and abrupt fluid velocity and directional changes.

Installations which include small pipe of varying sizes, numerous bends and turns create the conditions which the writer has invariably found associated with serious pulsation and vibration problems.

Because of the stimulus of competition within the industry since 1945, it is now possible to materially reduce the effects of pressure surge by the proper selection and installation of pulsation dampeners or suction surge chambers, or both. Reference to The Oil and Gas Journal, September 17, 1956, issue, should be made by those desiring a complete account of this method of surge control.

Despite the fact pulsation can be controlled, pulsation dampeners and surge chambers require maintenance intermittently. This requirement therefore remains as a partial disadvantage in unattended operation. Nevertheless, the risk barrier of pulsation has been pushed back very considerably. Development is continuing feverishly in this field of progress.

Cause of failure . . . The basic cause of desurger maintenance is failure of the precharged dampener cartridges, which require replacement at considerable effort and expense. The average initial cost of desurger equipment is $850 per pump.

Mid-Continent Pipe Line Co. is testing a liquid-pulse trap-type desurger at Drumright but conclusive test results are not available at this time. This type of equipment does not require a cartridge or other replaceable parts. The average initial cost of this desurger is $1,400. Obviously, the pulsation problem can adversely affect operating cost.

The author does not believe the indirect but far-reaching effects of surge, as related to efficient operation and low cost over a long term, have been fully appreciated by those entrusted with full profit responsibility.

An internationally famous pipeline engineer stated, "As a general rule lower operating costs for a given ca-

"serving all pipelines"

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pacity can be obtained by using a larger diameter instead of pressure and power applied by numerous pump stations to overcome the excessive friction loss in a smaller line or lines."[1]

Subsequent experience has shown the use of larger line and fewer pump stations to be a sound economic venture. Fewer pump stations and curtailed use of reciprocating equipment have thus eliminated many of the sources from which pulsation and surge problems originate.

Pulsation pressures . . . Peak pulsation pressures of 1,250 to 1,500 psi. are not uncommon on lines operating at 750 psi., when equipped with reciprocating equipment. Still higher pressures undoubtedly occur, because steel pump fluid cylinders are frequently cracked which have withstood static test pressures of 3,500 psi.

Since discharge lines are subjected to these surges, there is a limitation on the use of thin-wall pipe in areas adjacent to pump stations; a deterrent to the most economical use of high-cost steel. However, the most serious effects are observed in pumps and piping manifolds. Despite the facts, the obsolescence from which surge problems most frequently originate is currently being perpetuated in some new installations.

The relative importance of thin-wall pipe as related to steel cost per 1,000 bbl. per day of capacity * is illustrated in Table 1.

Chrome Plating

Chrome plating of machine parts is one of the most effective techniques of eliminative maintenance. The value of this method has been demonstrated and tested conclusively. No maintenance program can be fully effective which does not employ this technique. The savings in materials and labor are very favorable to reduced maintenance and operating cost. Cost of chrome plating usually ranges from 60 to 80% of new-parts cost. The service life of the chromed parts is usually doubled or tripled.

Some of the most common applications are pump crosshead pins, pump piston rods, engine crankshafts, etc. For example, the average service life of cold-rolled steel pump rods is about 5,000 hours, as compared with 15,000 and up for the hard chrome-plated rod. Thus, the cost of operating chrome rods is approximately 23% that of standard rods. Secondly, packing trouble and cost are materially reduced where chrome rods are used—another barrier to unattended operation is thus partially eliminated.

*Length of line 35 miles—800 psi. operating pressure.

Power Production

Manufacturers are keenly sensitive to industry's need for cost reduction. In those locations where electrical power is most economical, the cost may be further reduced by proper motor selection. A prime example is the weatherproof motor, incorporating a better cooling system than the explosionproof motor, permitting a higher rating, and requiring no shelter.

These motors are equipped with self-aligning sleeve bearings and may be purchased at less initial cost than the explosionproof motor. More reliable service life is an added advantage of this weatherproof motor.

An honest analysis of power cost must recognize that electrical units may operate with only the most minor service attention, aside from motor failure. Contrary to many peoples' ideas, this is also true of modern engines. Irrespective of the type of prime mover used, they must be applied conservatively and effectively maintained in a well-engineered installation. Otherwise, minimum power cost will not be realized.

Over-all fuel costs . . . As a major operating cost, energy or fuel consumption is of primary importance to the use of a continuous-service prime mover. Naturally, fuel cost is

GALVOMAG ANODES USED TO PROTECT 300-MILE LINE

This pipe line company had an old, bare, 8-inch product line that ran 300 miles across three states. The increasing number of corrosion leaks made it imperative to take corrective measures. CSI was awarded a cathodic protection contract on a competitive bid basis.

CSI engineers made soil resistivity tests, determined the size of anodes to use, and staked the anode locations. Then CSI's experienced crews installed 2300 Galvomags, the high-potential magnesium anodes developed by The Dow Chemical Company. CSI also furnished all other necessary materials and equipment, including augers and ditchers.

The job was done to the complete satisfaction of the pipe line inspectors.

You, too, will find it pays to call our stockholder employees—for engineering consultation, installation services, and quality cathodic protection supplies—for both rectifier and magnesium anode installations. Estimates or quotations without obligation. Call or write today.

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a primary concern for any prospective user. It is most important, however, to understand total cost of operation is not necessarily proportionate to fuel cost.

Generally, natural gas or LPG provides a premium fuel at less cost than diesel fuel, gasoline, or electricity, in most areas. Gas combustion is clean and lubricating-oil dilution or cylinder washing are both almost nonexistent. Long lubricating-oil life, extended period between oil-filter changes, and cleanliness in general are all normal for gas operation.

With gas and a suitable oil, gumming, carbon buildup, and varnish are less than with most other fuels. The overhaul periods can be materially extended, and overhaul cost at the end of extended runs also materially reduced. For example, Mid-Continent Pipe Line Co. recently operated a 2,894-cu.-in. gas engine 48,420 hours between overhauls. Total overhaul cost on this engine was $1,780.45.

Thus, the overhaul cost on this 280-hp. engine was $1.15 per horsepower year. The routine maintenance required between overhauls can be reduced to a very minimum by using high-tension ignition, platinum-point spark plugs, efficient lubrication and filtration, and adequate safety devices. This kind of performance and cost can be and is being accomplished on a wide scale. Any effective maintenance program can reproduce or even surpass this performance.

Protective Devices

Safety devices play an important part in any modern maintenance program. Thus, the accelerating trend toward semiautomatic and fully automatic pipeline pumps, lease-automatic-custody-transfer units, well pumps, salt-water-disposal pumps, water-flood pumps, gas compressors, etc., which are powered by both internal-combustion and electric prime movers.

To keep competitive, all of these various types of equipment placed in service today must be purchased with accessories and protective devices which will insure continued and extended operation while unattended. Careful selection of safety devices will assure high returns on company investment.

Preinstallation Maintenance

The contributions which maintenance has made bears small proportion to that which it can and will make in the future. Its greatest advance and potential lie along frontiers of preinstallation maintenance. This phase of maintenance involves its lesser-known functions, i.e., eliminating maintenance, arresting depreciation, and forestalling obsolescence.

A specific example which has revolutionized the pipeline industry is to be found in the widespread use of large-diameter thin-wall pipe (see Table 1). Much maintenance, depreciation, and obsolescence can and has been prevented by using large-diameter thin-wall pipe of high tensile strength.

This trend to larger diameter and to fewer stations and equipment was foreseen and advocated by William G. Heltzel, pioneer leader in pipeline industry, during the period 1927 to 1931 and probably earlier.[2] No other development in the catalog of pipeline achievements has contributed so much to the industry as this concept of rational pipeline design—and thereby, has indirectly contributed to preinstallation maintenance in like manner.

References

1. Heltzel, William G., "Trends in Pipe Line Practices," The Oil and Gas Journal, September 21 and 28 issues, 1946.
2. Heltzel, William G., "Important Developments Show Constructive Progress in Oil Pipe Line Operation," The Oil and Gas Journal, October 25, 1934.

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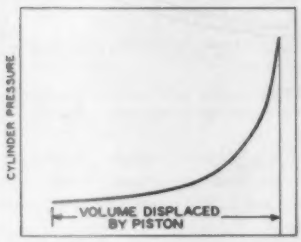
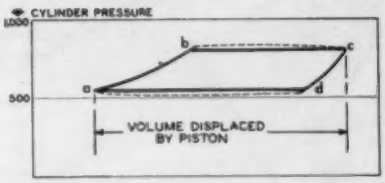
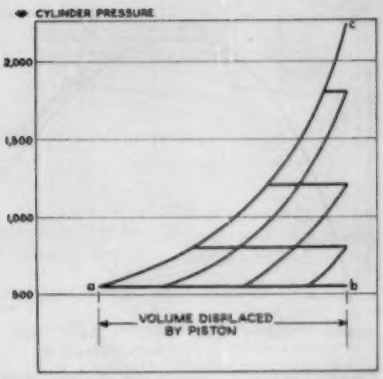
Do you know . . .



VOLUME and pressure change when gas is compressed in a closed cylinder. Fig. 1.



THEORETICAL compressor card (solid lines) and variations (dotted lines). Fig. 2.



COMPRESSOR cards with same suction but different discharge pressures. Fig. 3.

Why recip compressors act as they do?

- Why does compressor horsepower requirement increase to a maximum and then decrease as suction pressure is progressively lowered?
- As discharge pressure is progressively increased, why does compressor horsepower requirement increase to a maximum and then decrease?
- How do volume unloaders allow the operator to keep a compressor running at maximum efficiency?
- Why does lowering line pressure below design result in less efficient compressor operation?

These questions and many others often trouble people interested in the operation of gas lines.

They are answered here after logical, step-by-step development of the various concepts encountered in the compression cycle. And the answers are given simply, in terms of simple diagrams, rather than complicated mathematical equations.

BY C. S. KENWORTHY
Natural Gas Pipeline Co. of America

WHEN GAS OR AIR is compressed in a closed cylinder by means of a piston, the pressure in the cylinder rises as the volume is decreased. Fig. 1 illustrates how these pressure and volume changes take place in an internal-combustion engine. In an engine the clearance space is designed so that the pressure rises to a definite amount. If the engine cylinder does not fire, the pressure retraces practically the same path when the piston returns to its original position.

In the ordinary compressor cylinder with ordinary suction pressures the clearance is such that the pressure would be excessive if it were not for the fact that the discharge valves automatically open when the normal discharge pressure is reached. This allows the piston to deliver the compressed gas into the discharge piping system.

Compressor card . . . In Fig. 2 a theoretical compressor card is shown in solid lines. Dotted lines above the discharge line and below the suction line illustrate variations which actually occur due to piping and valve losses and to pressure surge in the piping.

Compression of the gas occurs from a to b, at which point the pressure of the gas in the cylinder has become equal to or slightly greater than the pressure in the pipeline. Therefore from b to c the gas is pushed out into the discharge piping by the piston. At c the piston starts on the back or suction stroke, the discharge valves are closed by the pressure in the discharge piping, and the gas left in the clearance space expands along the line c-d.

At d the pressure in the cylinder has been reduced to a value equal to or a little below the pressure in the suction piping. Further movement of the piston allows the gas to rush in and fill the cylinder at suction pressure along the line d-a.

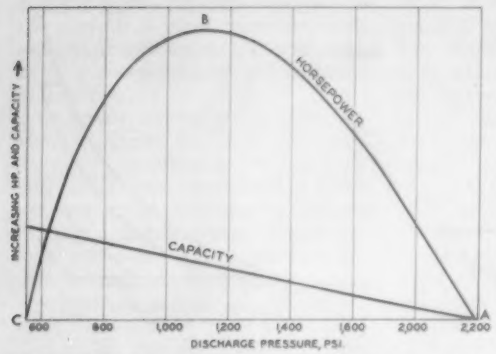
Constant Suction Pressure

Fig. 3 shows a series of compressor cards with the same suction pressure but with different discharge pressures.

With suction and discharge pressures equal (line a-b) the discharge and suction lines theoretically are one and the same, and no work is done. The compressor cylinder under this condition is delivering a maximum amount of gas.

Actually, as in Fig. 2, there are valve and piping losses which increase the discharge pressure above the theoretical and decrease the suction pressure. However, the effect of such losses is disregarded in order to make the comparisons clear. If these losses were included the horsepower curves would be changed, but the principles involved are the same.

It becomes evident on inspection of the indicator cards that as the discharge pressure is increased the horsepower required by the compressor at first increases rapidly, reaches a max-



CHARACTERISTIC operating curves with a constant suction pressure and variable discharge pressure. Fig. 4.

imum at some discharge pressure, and then decreases to zero. At this last condition, line a-c, the pressure just reaches the discharge pressure at the end of the stroke and no gas is delivered.

The piston under this condition compresses and expands the gas just as an engine piston does. In actual operation the pressures should not be allowed to approach this condition for leaky piston rings or valves will cause the cylinder to heat up rapidly.

Fig. 4 translates the data from Fig. 3 into curves of compressor horsepower and capacity which are the characteristic operating curves with a constant suction pressure and a variable discharge pressure. The point of maximum horsepower is sometimes termed the peak discharge. It is now easy to understand why decreasing the discharge pressure from A to B increases the horsepower and yet, with a further decrease, results in a decrease in horsepower.

Generally, in pipeline stations the operation is between B and C and the discharge pressure at which the horsepower is a maximum does not occur. Operation in general is at nearly constant discharge pressure with the variations occurring in the suction pressure.

Constant Discharge Pressure

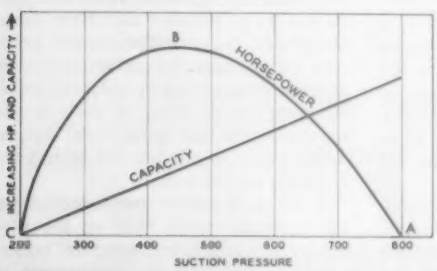
Fig. 5 shows a series of compressor cards with the same discharge pressure but with different suction pressures.

With maximum suction pressure equal to the discharge pressure, line a-b, theoretically no work is done. Actually, because of losses, a considerable amount of work is done on the gas as shown in Fig. 3. The capacity is at a maximum.

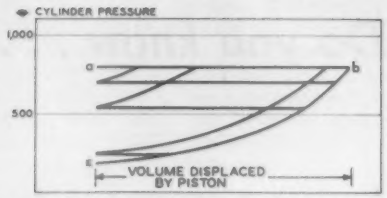
As the suction pressure is lowered the horsepower at first increases. It becomes a maximum at some suction pressure and then as the suction is further reduced the horsepower becomes less and less. Finally, at the lowest suction pressure shown the gas is compressed and expanded along line c-b. Under this condition no gas is being delivered and the horsepower is zero.

With a sufficiently low discharge pressure and a small cylinder clearance it is possible for the gas to be expanded down to a vacuum. This could allow air to be drawn into the cylinder through the packing case. This makes it desirable when loading a compressor to partially open the suction valve before closing the bypass valve.

Data from a series of indicator cards as in Fig. 5 result in curves of capacity and horsepower as shown in Fig. 6. These curves show the operating characteristics with a constant discharge pressure. As the average pipeline station operates over long periods of time with almost constant



OPERATING characteristics with a constant discharge pressure. Fig. 6.



COMPRESSOR cards with same discharge but different suction pressures. Fig. 5.

discharge pressure these particular curves become important to the understanding of pipeline-compressor operation.

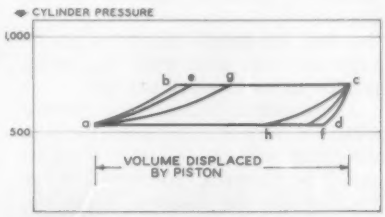
Many main-line booster stations operate normally between A and B, whereas many field stations operating with high differential pressures operate between B and C. Units operating in this latter range are subject to sudden increases in load whenever the suction pressure increases rapidly. For instance, where several units are operating in parallel and one of them is shut down the load on each of the remaining units increases. In some installations severe overloads can occur unless changes are made in the operation.

On most main-line stations, where the compressors are operating between A and B, the load on each unit is reduced.

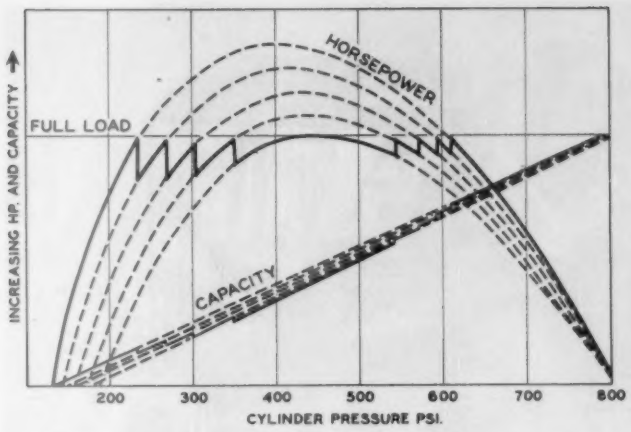
Volume Unloaders

Fig. 7 shows three compressor cards with different cylinder clearance volumes. a,e, c, and f outline a card similar to the one shown in Fig. 2. With a smaller clearance volume the card produced is shown as a, b, c, d. This results in an increase in horsepower as well as an increase in capacity. Card a, g, c, h shows the cylinder operation with a large clearance volume. In this case the horsepower is very considerably reduced, and is accompanied by a corresponding decrease in capacity.

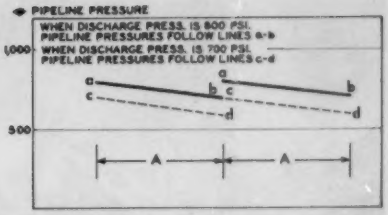
In Fig. 8 a set of curves shows the operation of a compressor cylinder with a number of different volume unloaders open. Operation is at constant pressure. In order to operate engine-compressor units over a wide range of conditions at or near full



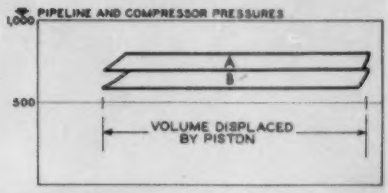
COMPRESSOR cards with different cylinder clearance volumes. Fig. 7.



OPERATION of cylinder with a number of different volume unloaders open. Fig. 8.



PRESSURE DROP at different discharge pressures. Fig. 9.



HORSEPOWER required for different pressure boosts. Fig. 10.

load, several steps of unloading are necessary. The complete curves for each of the different clearance volumes are shown.

Only the parts of these curves showing operation to maintain as near full load as possible without overloading are shown in solid lines. The remainder of each curve is shown in dotted lines. Operation along the solid line results in maximum efficiency as well as in maximum capacity. It is evident from the curves that the units can be operated efficiently over a wide range of suction pressures.

Combining Pipeline and Compressor Operation

The pipeline is of course designed for a maximum allowable working pressure. Any pressure above this should be prohibited. As a booster station builds the discharge pressure up to a maximum and the gas flows through the line, the friction of the gas and of the pipe causes the pressure to gradually drop down to some pressure which becomes the suction pressure at the next station.

In a given pipeline this pressure depends largely upon the amount of gas which flows through the line. The lower the pressure of flowing gas, the greater is the pressure drop for each mile of pipeline.

Fig. 9 line a-b shows the pressure drop as almost a straight line curving downward very, very slightly as the continuous drop in line pressure causes an ever-increasing pressure drop per mile of pipe. This curve indicates a discharge pressure at each station of 800 psi. and a suction pressure of 700 psi.

An additional flow curve c-d shows a discharge pressure at each station of 700 psi. and a suction pressure of 585 psi. The increased pressure drop of 15 psi. is caused by the increased friction experienced with the lower flowing pressures.

Even if the pressure drop did not increase the horsepower required to pump the gas would be increased a great deal. It so happens that the horsepower required to pump a given quantity of gas measured at standard conditions is almost proportional to the number of compressions (the absolute discharge pressure divided by the absolute suction pressure) regardless of the actual pressures involved.

Fig. 10 illustrates the above statements fairly well without any formulas involved. With indicator card A, a certain horsepower is required to pump the gas from 700 psi. suction to 800 psi. discharge.

THE AUTHOR

C. S. Kenworthy is general superintendent of compressor stations on the Texas-Illinois system and Natural Gas Pipeline Co. of America. He has been in work connected with engines and compressors since 1923 when he graduated from Cornell University with a mechanical-engineering degree. He was associated with the Worthington Corp. for 15 years before joining Natural Gas Pipeline.

Indicator card B, taken on the same size compressor cylinder, shows the horsepower required to pump the gas from 585 psi. suction to 700 psi. discharge. It is evident that the horsepower required for this latter condition is slightly greater than for the 700-800 psi. condition. However, in card A the compressor cylinder is being filled with gas at 700 psi. pressure instead of at 585.

It now becomes evident that the horsepower required to pump a given amount of gas at the lower pressures, measured at standard conditions, is increased by somewhat more than the ratio of

$$\frac{700 + 14.5}{585 + 14.5},$$

or 1.19. The atmospheric pressure, 14.5 psi., is added to the gage pressures to obtain absolute pressures, as the ratio then represents the correct proportion of gas at these gage pressures.

If a pipeline is designed with a certain total horsepower to deliver a given quantity of gas at 800 psi. discharge pressure it now is evident that at any lower pressure the quantity of gas delivered must be decreased.

Any large reduction in pressures can easily result in pressures which do not load the engines with the compressor cylinders which are in use. This condition would still further reduce the capacity of the line.

The increase in horsepower requirements with reduced pipeline operating pressures is seen to be highly important. Unless there is some circumstance to prohibit it the discharge pressures should be maintained as close as practical to the maximum designed working pressure.

DITCHER CUTS 40-in.-deep trench through Nebraska farm land. Two machines were used to keep ahead of the pipe gangs.

Two pipe gangs put down 6-in. at

LINEUP is made by one of two gangs each using two external clamps, and . . .

STRINGER BEAD is run by two welders with clamp remaining on pipe for about 15 seconds.

CLEANING AND PRIMING operation proceeds ahead of coating and wrapping (below).

rate of 5 miles per day

BY GENE KINNEY
Assistant Pipeline Editor

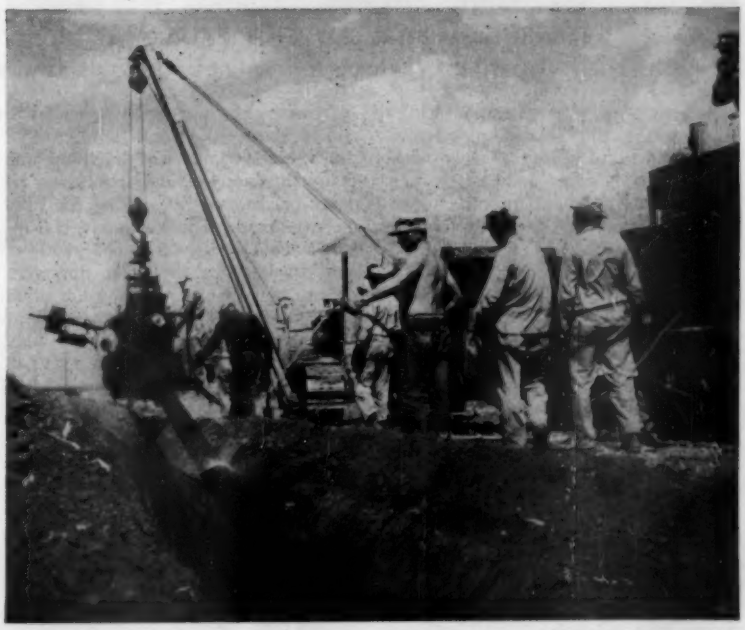
PIPE WAS LAID this summer at rates up to 6½ miles in a day by a single Williams Brothers Co. spread on the 6-in. Kaneb Pipe Line in Kansas and Nebraska.

Unusual production was possible through use of two pipe gangs. In spite of heavy rains which shut down construction a few times, spread progress averaged almost 5 miles per calendar day on the first part of the project.

The original Kaneb system, built in 1953, consists of 46 miles of 8-in. and 200 miles of 10-in. from Wichita, Kans., to Geneva, Neb. The current expansion program will add 279 miles of 6-in. to the system. It includes 111 miles from the Cooperative Refinery Association refinery at Phillipsburg, Kans., to the Kaneb line at Geneva, and a 169-mile extension from Geneva to Yankton, S. D. Terminals are being constructed at Norfolk, Neb., and Yankton.

Pipe Laying

Rather than use two spreads on the project, the contractor chose to field



COATED PIPE is sprayed with water to set coating before lowering into padded ditch.

BACKFILL follows closely after doping operation.

one large one with two pipe gangs. By working the second pipe gang, progress was increased sharply without a corresponding increase in personnel and equipment for other operations. Since the pipe gang sets the pace, the rest of the spread adjusts accordingly.

The Phillipsburg-Geneva line was kicked off July 6. It was completed 24 days later for an average progress of 4⅔ miles per day, even with some weather delays. After a 2-week delay for right-of-way buying, the Yankton extension was started.

Each pipe gang had two welders on stringer bead and three on hot pass. With a single gang the contractor reported an average of 450 40-ft. joints per day. By adding a second gang production was boosted by 200 joints, or 44%. With two gangs working, the spread regularly laid more than 25,000 ft. per 10-hour day.

Each gang used two external clamps for lining up. The stringer bead was run in about 30 seconds, and by that time another joint was lined up and ready for tack welding. There was no delay occasioned by waiting for lineup to be made. The gangs would leapfrog each other by 2 miles.

Six welders on the firing line were able to make finish welds at the rapid pace set by the lineup crews. They averaged 100 to 110 welds per day on the ultrathin-wall pipe (X42 0.188-in. wall). The pipe gangs were equipped with 300-amp. tractor-mounted welding machines and the firing line had 200-amp. machines.

An extra tie-in crew was necessary to keep up with the rest of the spread.

Ditching

Two ditching machines were operated 12 hours a day (one was double shifted part of the time) to keep ahead of the pipe. Ditchers normally used for large-diameter pipe were fitted with small wheels to cut the 20 by 40-in. trench.

The pipeline route traverses pasture and farm land primarily; hence there was no problem in making the ditch. No rock was encountered, except for a 15-mile stretch along the Kansas-Nebraska state line. It was cut by a ripper pulled by a heavy tractor without any blasting being required.

Coating and Lowering in

The dope gang maintained the fast pace by working longer hours. The gang coated and wrapped 28,000 ft. in one 14-hour working day when peak production was reached. Pipe was protected with an asphalt enamel, glass, and felt outer wrap.

The coated pipe was cradled into the ditch directly behind the dope machine. To prevent damage to the coating, the ditch was padded with a small mound of fine soil every 30 ft. Just before the pipe reached the ditch, the pad was sprayed with water to soften it. The pipe was sprayed also to cool and set the coating.

A bulldozer followed close behind backfilling the ditch.

Four to five slack loops per mile were left in the line.

The line was pressure tested with products at 1,300 psi.

River Crossings

The line crosses four major rivers —the Platte, Republican, Loup, and Missouri, the Missouri being the widest at 3,000 ft. Trench for the Missouri crossing was made with a suction dredge while the others were dug out with a dragline.

Single crossings of 0.500-in.-wall pipe were installed at the rivers. Pipe was buried to a depth of 5 ft. below the channel. With the small-diameter pipe with heavy wall, no weight clamps were needed for negative buoyancy.

Contractors

Pipe Line Technologists, Inc., Houston, had the turnkey contract for engineering, management, and inspection. Prime contractor for the main line was Williams Brothers Co., Tulsa. H. L. (Red) Davis was superintendent and G. R. Hamilton was spread man for Williams Brothers. Ed Carpenter was chief inspector for Pipe Line Technologists.

Coating was subcontracted to Secrest Pipe Coating Co., Tulsa. Road crossings were subcontracted to Oklahoma Road Boring, Inc., Tulsa. Dredging of the Missouri River was subcontracted to J. C. Johnson Dredging Co., Houston. Parkhill Truck Co., Tulsa, had the stringing contract.

BY PAUL REED
Pipeline Editor

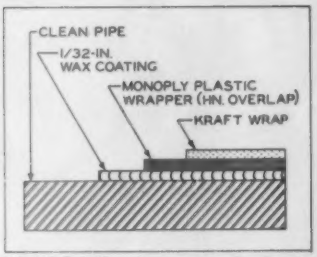


DIAGRAM of wax-and-plastic-wrapper coating method.

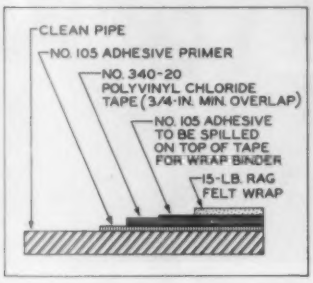
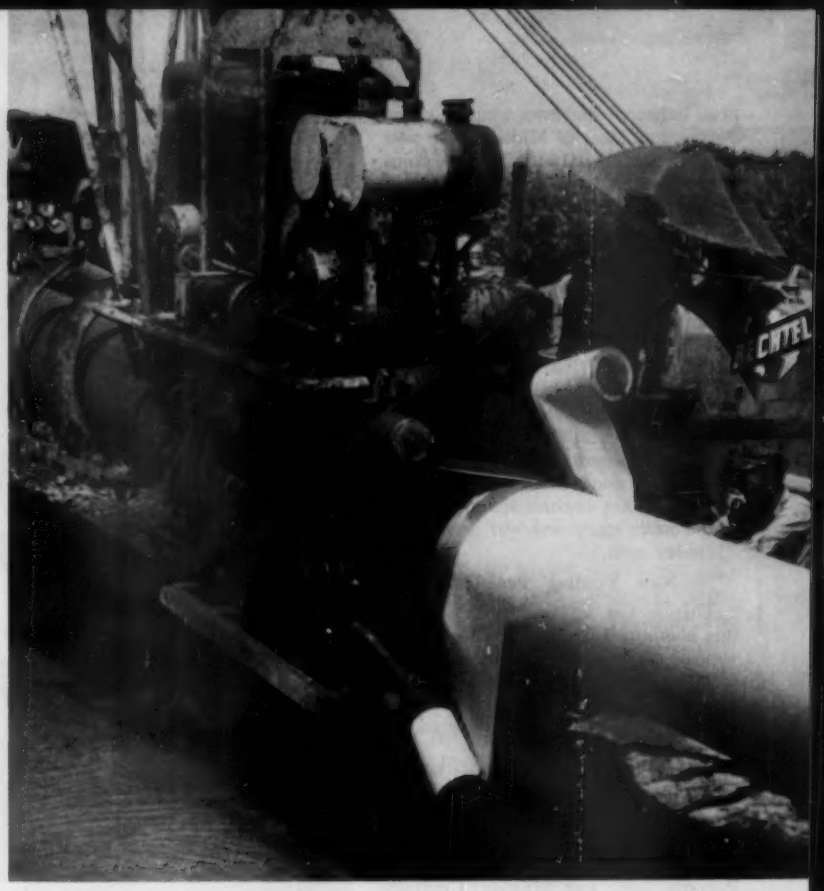

CLEAN PIPE
NO. 105 ADHESIVE PRIMER
NO. 340-20 POLYVINYL CHLORIDE TAPE (3/4-IN. MIN. OVERLAP)
NO. 105 ADHESIVE TO BE SPILLED ON TOP OF TAPE FOR WRAP BINDER
15-LB. RAG FELT WRAP

DIAGRAM of plastic-tape procedure.



HOT WAX, plastic tape, and kraft-paper application. This machine combining cleaning, coating, and wrapping operations is also used to apply adhesive plastic tape and felt. Both types of protection were applied in Illinois.

Midwestern construction practices are different

Project includes plastic external coatings, internal coating for nearly its entire length, varied approaches to river-crossing, trenching, and certain field methods.

CORROSION ENGINEER Robert G. Ransom examining polyvinylidene chloride-butyl rubber tape at river-crossing field joint for Midwestern.

CHANGES in pipeline-construction practices are exemplified in the laying of Midwestern Gas Transmission Co.'s 350-mile, 30-in. line—the largest single new project in the United States under construction this summer. Significant innovations were seen in the company's design and contractors' methods during the author's recent trip to four construction spreads. Midwestern Gas Transmission Co. is a wholly owned subsidiary of Tennessee Gas Transmission Co.

Advanced planning prepared the way for fast construction of this important strategic undertaking. Nearly all of the construction has been done in summer months. Tennessee Gas Pipe Line Co., a division of Tennessee Gas Transmission Co., will deliver Midwestern's gas supply at a connec-

tion between the two systems near Portland, Tenn. Midwestern will transport this gas 350 miles to a point near Joliet, Ill., and deliver it into the facilities of Chicago District Pipeline Co. (a subsidiary of Peoples Gas Light & Coke Co.). The FPC permit was issued in the middle of May.

This article is mostly concerned with contractors' methods. The main features of the company's program must be stated first.

All pipe was available when the job started, according to the characteristic policy of Tennessee Gas Pipe Line Co., sponsoring the project. The work was divided into six spread-sections. They included four spreads of 50 miles each and two spreads of 75 miles each.

New Coating Practices

This is the first complete line of this magnitude to be internally coated almost completely with epoxy resin from end to end. Internal coating was done at yards under separate contracts before pipe was delivered to the right-of-way.

Approximately 60% of the line is being coated externally with hot coal-tar enamel—applied at the four spreads of Grayco Constructors, Inc.; Sharman, Allen, Gay & Taylor, Inc.; Panama, Inc., and Majestic Contractors.

The remaining 40% is coated with two basically different techniques—Mummy wrap and Plicoplex tape—applied as the entire pipe protection at the two spread sections of Bechtel Corp.

For these techniques, the procedure followed is to have 18 miles wrapped with tape on the downstream side of two proposed future compressor-station sites. These are in the two Bechtel spread-sections of 74 miles each at the northern end of the line in Illinois.

HOT COAL-TAR ENAMEL wrapped with asphalt-impregnated glass outer wrap applied at Grayco spread near Bowling Green, Ky.

The outside of the tape is a smooth polyvinylidene chloride material; inside is sticky butyl rubber. Total thickness of the tape is 20 mils. Width of tape for overland wrapping is 8-in. Adhesive primer is applied to the pipe immediately before taping. Tape is protected by an outside wrapping of asphalt-saturated felt.

The same coating-and-wrapping machine is used for applying adhesive and tape as is used for the Mummy-wrap application. This dope machine provides for all operations, including cleaning, in one unit, thus eliminating the cleaning machine which usually runs ahead of the dope machine.

For the Mummy-wrap technique, wax is first applied by the dope machine from the single kettle operated in dope-gang operations. Kettle temperature is held at about 300° F. Wax thickness on the pipe is 1/32-in. The wax is immediately wrapped with a polyvinyl wrapping called Monoply. This is covered by an outside wrapping of kraft paper.

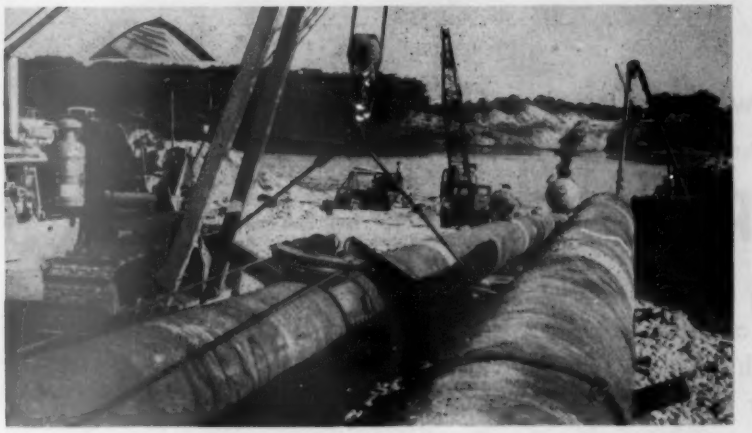
In the application of the wax, a specially developed spring-coil device drags off excess wax. Extra wax is put on top to give a double wax coating there.

The Mummy-wrap coating-and-wrapping operations were observed to progress smoothly. It was reported on the job that they are as fast or faster than those for hot coal tar. The regular dope gang for this work consists of 13 men: 9 laborers, 3 tractor drivers, and a foreman plus 2 truck drivers who bring in supplies of material.

THREE STRINGER BEAD WELDERS working together in the Grayco pipe gang.

Double Jointing

Pipe for the two Bechtel spreads was double jointed with automatic



FIRST SECTION of line with pontoons launched by Collins at Des Plaines River, Ill. Stabilizing wrench held by tractor in foreground prevents pipe from turning. Snubber line holds pipe back.

YO-YO BUCKETS (in right foreground) were pulled by wire line to dig the entire trench across Des Plaines River.

submerged-arc welding at a specially developed unit. This unit attracted attention early this year because of its novel use of a glass-fiber belt to back up the weld and its "dog-leg compensator" for securely holding the pipe during rotation.

It was reported that on good days the usual Bechtel pipe-gang output on this project was 130 welds per day, giving daily production of 10,400 ft.

Grayco Construction Methods

Grayco was working in the roughest section of the project. Terrain varied from rolling country to steep choppy limestone hills with thin soil. Altogether this spread section No. 1 encountered about 25% rock. In spite of this, good progress had been made.

Average daily output of the Grayco pipe gang was reported as 190 welds on 40-ft. joints—7,600 ft. per day.

Welding was single hand, with the contractor furnishing all welding equipment. There were 3 stringer-bead welders, 4 hot-pass welders, and 17 to 18 welders in the firing line plus 2 tie-in welders and a utility welder. Lineup was done with a pneumatic clamp.

Pipe protection by hot coal tar was furnished by hot service enamel for the section downstream from the compressor station near Portland and by modified enamel for the rest of the spread section. Enamel is protected by an asphalt-impregnated glass outer wrap. Rock shield gave additional protection in rocky sections.

Among notable features of Grayco practice are the following operations:

In the brush gang, brush and trees up to 2 ft. in diameter are all cleared with a D-8 dozer equipped with a timber blade.

Right-of-way is made passable in wet weather by laying discarded steel pipe as culverts for drainage. Pipe joints are reclaimed by the cleanup gang. Grayco has been using discarded pipe for culverts for more than 4 years.

Ammonium nitrate (fertilizer) mixed with diesel oil is being used this year by Grayco as explosive in dry rock. Cost is a third of that for dynamite.

Larger skids 5 by 6 in. are preferred to the common size of 4 by 6 because of less breakage.

Wire-cup brushes are used on the buffing machine which prepares bevels for the stringer-bead welders. At the front end of cleaning-machine operations wire-cup brushes are used; regular block brushes follow behind the chain.

All roads have signs with road numbers to guide truck drivers in the vicinity of the work. By expediting deliveries these signs have saved time and money.

Throughout the Midwestern construction operations, pipe is cradled into the ditch behind the dope machine except in very rocky sections.

River Crossing

At the Des Plaines River near Joliet, Collins Construction Co. pulled an 1,134-ft. crossing from launching tracks which crossed over the top of a hill in an unusual way. The hill was cut down so that pipe would maintain the specified 2,500-ft. radius needed for safeguarding the condition of the pipe, enamel coating, and concrete coating.

Trenching was done entirely with "Yo-Yo" buckets pulled by winch lines across the river—even digging through rock. There were no dragline barges used in the river.

During launching on the rubber-tired, pivoted launching units the pipe was held in position by boom tractors holding stabilizing wrenches, made on the ice-tong principle.

The author saw a 592-ft. section launched for the first line, preceding a second section of 542 ft. Later a second 1,134-ft. 30-in. line was to be launched. Total weight of this line in the air is 580,000 lb. With pontoons in the water it would be only 22,680 lb.

Pipe Specifications

Pipe for the Midwestern project consists of the following:

X-52 pipe—for congested areas, highways, railroads, and valve settings, 4.6 miles .500-in. wall; river crossings, station sites, and some highways, 6.9 miles .625-in. wall; and crosscountry, 341 miles .375-in. wall.

X-56 pipe—crosscountry, 5.0 miles .375-in. wall.

What you ought to know about

Pepping up tired producers

Trying to stimulate a well in a depleted reservoir can lead to expensive failure. This article tells you how to choose the correct well for fracturing, acidizing, or other workover techniques.

BY NORMAN LAMONT
Department of Petroleum Engineering,
University of Texas

BOTTOM-HOLE PRESSURE build-up tests can be used in many cases to determine if a well is susceptible to stimulation by applying the damage factor, completion factor, or similar methods. To be successful, the job must result not only in an increased rate of production, but also in a reasonable payout period and in an increased ultimate recovery.

Production records before and after the stimulation must be analyzed to indicate the success or failure of each job. The production rate-time and cumulative-production curves are forms which are easily analyzed.

Pressure buildup . . . Pressure distribution in a homogeneous, horizontal reservoir of uniform thickness is described by the partial differential equation of motion, provided the fluid obeys Darcy's law and its compressibility and viscosity remain essentially constant over the pressure and temperature ranges of the reservoir, and its density follows the exponential type law.

In applying this to pressure buildup in a well, D. R. Horner proposed use of the "point-source" solution of this differential equation, which is:

$$P_w = P_s + \frac{q\mu}{4\pi k h}\left[\mathrm{Ei}\left(-\frac{r_w^2 f \mu c}{4k(t+\Delta t)}\right) - \mathrm{Ei}\left(-\frac{r_w^2 f \mu c}{4k\,\Delta t}\right)\right] \quad (1)$$

Since the value of the function $\mathrm{Ei}(-x)$ is approximately equal to $(\ln x + 0.5772)$ for large values of Δt, Equation 1 can be written in its approximate form, using oil-field units, as:

$$P_w = P_s - \frac{162.5\, q\mu}{B k h} \log \frac{t+\Delta t}{\Delta t} \quad (2)$$

Presented at the sixth annual West Texas Oil Lifting Short Course, Texas Technological College, Lubbock.

where:

P_s = static pressure, psi.
P_w = well-bore pressure, flowing, psi.
q = production, B/D.
k = permeability, md.
h = height, ft.
μ = viscosity, cp.
B = formation volume factor.
t = flowing time, hours.
Δt = shut-in time, hours.

Use of this equation assumes that the well is in an infinite reservoir and that the well radius is negligible. It also assumes that the production, q, is constant for time, t, a condition which is seldom satisfied. It is suggested by Horner that time, t, can be approximated by dividing the total cumulative production during the test by the last established production rate.

This calculated time shall be designated by t_c. We may write then:

$$P_w = P_s - \frac{162.5\, q\mu}{B k h} \log \frac{t_c+\Delta t}{\Delta t} \quad (2a)$$

The well pressures during flowing time, t_c, and shut-in time, Δt, when plotted against the log $(t_c+\Delta t)/\Delta t$ will describe the buildup of pressure. Extrapolation of this curve to infinite shut-in time should give static bottom-hole pressure, P_s.

In a limited reservoir, or in a reservoir from which a large volume has been produced, the extrapolated pressure will be too high. In such cases, the extrapolated pressure may be corrected to actual static pressure by the method suggested by Horner.

The pressure drop per log cycle from the straight-line buildup curve, i.e., its slope, Z, can be read directly from the plot of the data. The transmissibility of the formation, kh, can be computed from:

$$kh = \frac{162.5\, Q\mu\, B}{Z} \quad (3)$$

If the height, h, is known, the permeability, k, can easily be computed. This permeability is the average reservoir permeability. It is not this value that is of interest here, but the permeability immediately around the well bore which may be reduced due to completion damage. This damage is reflected in the nonlinear portion of the buildup-pressure curve.

Van Everdingen described the reduction in capacity of a well as being the result of a phenomenon which he called "the skin" rather than a permeability change.[8] From the "point-source" equation, he developed the solution to be:

$$P_s - P_f = \frac{70.6\, q\mu}{B k h} \times [\ln(T + \Delta T)/T + 0.809 + 2S] \quad (4)$$

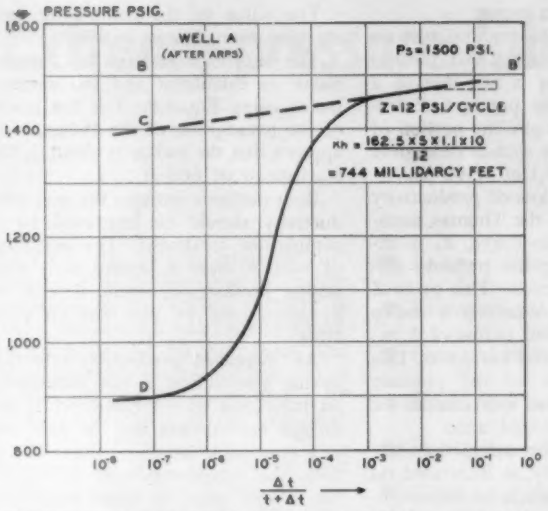
where:

T = dimensionless flowing time = $4\,kt/f\mu c r_w^2$.
ΔT = dimensionless shut-in time.

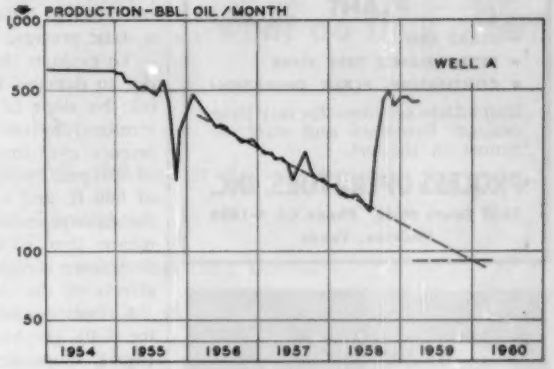
Selecting the Well

Before using pressure-buildup data for the selection of wells for stimulation, the causes of reduced productive capacity should be examined. From the foregoing discussion, it is obvious that one is damage to the formation around the well bore. A second could be a loss or depletion of reservoir pressure.

In the latter case, no stimulation



BUILDUP TEST on Well A indicates that decline in production is not due to decline in formation pressure. Fig. 1.



PRODUCTION HISTORY of Well A shows that increased production resulted from hydraulic fracturing. Fig. 2.

technique will be able to increase productivity. A low static pressure should be immediately obvious from extrapolation of the buildup curve to infinite shut-in time.

Evaluation of formation damage will be of prime concern in deciding which wells should be selected for stimulation. As a general rule, then, it can be stated that the well with the greatest damage should respond best to such stimulation, all other factors being equal.

Several methods have been suggested for this damage evaluation.[3 4 5] Solution of the van Everdingen equation (Equation 4) for S would do, but this requires a knowledge of well-bore radius, fluid compressibility, and porosity. This does not imply that it is not a good method. Examples of its application to acidizing and reperforation are given in the original paper.

Two methods for evaluating damage are those of Thomas and Arps, both of which are simple, rapid, and adaptable to field conditions.

Thomas, using the "point-source" solution of the flow equation as given by Horner, takes the average productive capacity, Equation 3, and combines it with the radial flow formula to give the damage factor (DF) which is:

$$DF = 1 - \frac{2Z \log r_e/r_w}{P_s - P_f} \quad (5)$$

The factors, Z, P_s, P_f, are all obtained from the building curves as previously described. The reservoir and well radii must be obtained from other sources. A large value of DF, approaching unity, indicates high damage.

Arps suggested that this damaged area could be characterized by a completion factor (CF) which he defined as the percentage of the theoretically possible productivity which actually has been obtained. The equations for a solution gas drive reservoir are:

$$CF = \frac{\text{theoretical drawdown}}{\text{actual drawdown}}$$

$$= [2 \log (0.6065)\, r_e/r_w] \frac{Z}{P_s - P_f} \quad (6a)$$

and for undersaturated reservoirs:

$$CF = \frac{0.001421\, k\, t}{f \mu c r_w^2} \frac{Z}{P_s - P_f} \quad (6b)$$

where:

t = shut-in time, minutes.
r_w = well radius, in.
c = compressibility, psi.$^{-1}$

Solutions of these equations are easily obtained by a graphical procedure which will be explained in the example problem.

In general, the smaller the CF is, the greater the damage is. It is related to the Thomas damage factor by:

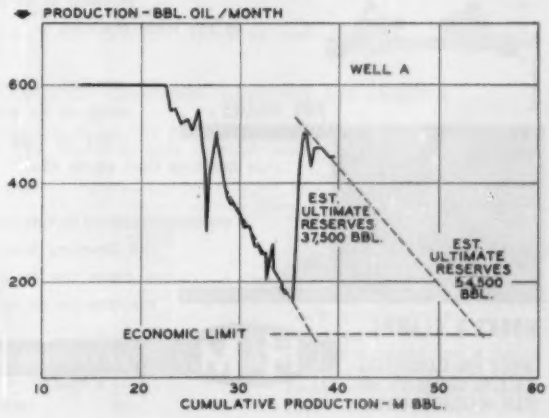
$$CF = (1 - DF) \times 100 \quad (7)$$

Example Problem

To illustrate the methods of evaluating wells for stimulation consider a hypothetical well A that is completed in a 10-ft. thick sand. The oil has a viscosity (μ) of 10 cp. Formation-volume factor (β) is 1.1. Production is 5 bbl. of oil per day.

A buildup test is conducted as follows:

1. The well is flowed for several days until a constant rate of production is established.
2. Bottom-hole pressure is measured throughout the flow period.
3. Shut-in well, recording bottom-hole pressure during period.
4. Plot pressures against $\Delta t/(t+\Delta t)$



WELL A recovery was increased from 37,500 to 54,500 bbl. by well stimulation. Fig. 3.

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The results of the buildup test on well A (Fig. 1) indicate that the decline in production is not due to a decline in formation pressure. Extrapolation of the straight-line portion of the curve to infinite shut-in time gives a static pressure (P_s) of 1,500 psi.

To evaluate the loss of productivity due to damage, by the Thomas method, the slope of the curve, Z, is determined by taking the pressure difference over one cycle. This gives Z of 12 psi./cycle. Assuming a radius of 660 ft. and a well radius of 3 in., the damage factor (DF) is 0.676. This means that 67.6% of the pressure drawdown is required to overcome the effects of the damaged zone.

Calculation of the completion factor (CF), graphically, is illustrated on Fig. 1. Stepwise this is as follows:

1. Draw the horizontal line, B-B′, through the static pressure, P_s.

2. Extrapolate the straight-line portion of the buildup curve to the left a distance of n cycles. Average value of n is 6. A more precise value can be calculated by setting it equal to the logarithm of the time term in Equation 6b.

3. The vertical distances at this point represent the actual drawdown (B-C) and the theoretical drawdown (B-D).

The value of the completion factor (Equation 6a) is 16.6%.

The difference between the damage factor as calculated and the damage factor using Equation 7 is the result of the assumption of the radius, r. It appears that the radius is about 3,500 ft., instead of 660 ft.

Both methods indicate the well productivity should be improved by a stimulation treatment. The selection of well A over a second well with similar productivity would depend on a comparison of the two CF's or DF's.

An increased production rate following stimulation is not necessarily an indication of increased profit, although the expense may be paid out in a reasonable length of time. Therefore, the recommendation to stimulate a well must be based upon factors besides the damage evaluation. Usually, the profitability will be predicted on similar, successful jobs. The success of a job can be determined by an analysis of the future production after stimulation.

To illustrate this point, assume that well A was hydraulically fractured after the above buildup test. The production history indicates the increased production, Fig. 2.

This does not indicate, however, that the job increased the ultimate recovery from the well. When the production rate is plotted against cumulative production, Fig. 3, and the new decline is extrapolated to the economic limit, it is seen that the recovery was increased from 37,500 bbl. to 54,500 bbl. Therefore, the stimulation of well A should be an economic success.

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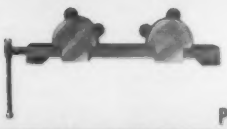

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Extreme-pressure lubes in drilling muds

. . . what do they offer?

- Longer life for bits.
- Prevention of wall sticking of drill string.
- Lower downhole torque.
- Reduced wear on reciprocating parts.
- Protection from corrosion damage.
- Good lubrication in highly inhibited muds and in water-base muds generally.

BY W. C. BROWNING
Director of Research
Milwhite Mud Sales Co., Houston.

WHEN the extreme-pressure (EP) lubricants in drilling mud were first suggested to the drilling industry in 1958, the concept was focused directly on prolonged bit life. Since that time, there has been a fair amount of field work and the scope of the EP additives has been greatly expanded.

Summing up . . . To date we have completed more than 60 tests with our water-base lubricant. On these field tests, we have found no detrimental effects on mud properties caused by the addition of the water-base EP additive. We have found that addition of the water-base additive produces a lubricating effect measurable on field EP testing equipment.

In drilling, the additive reduces the torque, reduces bore-hole friction, improves bit-bearing life, and reduces wear on all reciprocating parts exposed to the mud stream. The additive reacts with metal surfaces, particularly those that have been exposed to higher temperatures, to form a rust-resistant coating.

Little of the material need be added to maintain measurable EP properties. Unless circulation is lost or there are similar problems, 1 to 1½ gal. of additive per barrel of mud is all that is required.

Field Results

The only proof that can result from field work will be of statistical nature. Variables are never sufficiently under control to prove points in a very satisfactory manner in production drilling. If individual results are sufficiently outside of the norm of usual experience to make the deviations significant, however, we may gain encouragement from an individual test to promote further testing. With enough testing we can establish adequate background to enable an objective appraisal of the value of a product or technique.

The field results summarized here are not presented as proof positive of value of water-base lubricants for drilling muds. They are given as interesting deviations from the norm indicating the high probability of favorable results. In all our tests so far, all of the deviations have been positive. This fact is in itself very encouraging for the future of water lubricants and EP agents.

Many of the field results are quite incomplete, for example, the data shown in Table 1. In drilling near Liverpool, Tex., one operator had difficulty penetrating a hard formation. After introduction of a water-base EP lubricant, he could increase pressure on the bits without bit bearings becoming locked. It is likely that bit types might have been safely changed to speed drilling.

Inadequate as this information is, it is representative of the type of before-and-after information most frequently obtained. The day-tour driller, the evening-tour driller, and the tool pusher all felt that positive benefits were obtained. These feelings have to be accorded some weight in assessing the value of the lubricant treatment.

A West Texas test . . . In a field test near Odessa, Tex., a well was drilled with water-base lubricant. Its performance was compared with an offset well 2,000 yd. away. On the test well, drilling was with a gel mud below 4,650 ft. whereas the comparison well did not mud up until 7,400 ft.

When the test well reached 10,366 ft., it was 6 days, 16 bits, and 185 rotating hours ahead of the comparison well. In addition, the comparison well had only two drill-stem tests compared to seven drill-stem tests on the test well.

Again, we have no indisputable proof of superior drilling and bit life but the performance was sufficiently above the norm of the experience of the driller to convince him that the lubricant treatment was of economic value.

The driller in this instance also reports below-normal wear on liners, piston heads, and piston rubbers.

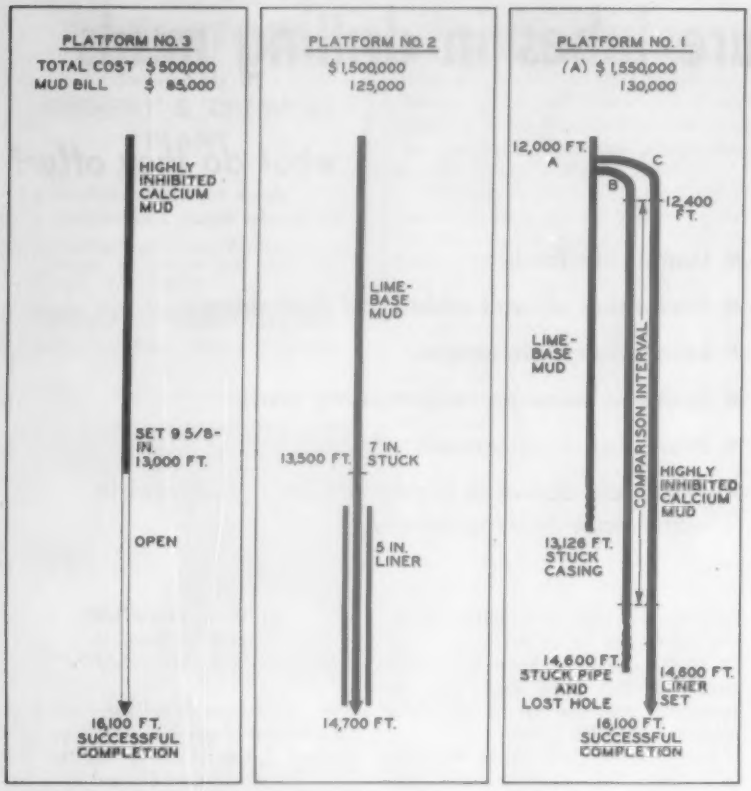
Good on wall sticking . . . The water-

TABLE 1—EFFECT OF LUBRICANT ADDITION ON DRILLING

Bit records after drilling out of 11,300 ft. of 7-in. casing; 4⅛-in. bits were used (OWV). This record is only through hard formation.

Feet made	Hours run	Wt. on bit, lb.	Condition of bit
39	12	12,000	Teeth good—locked
67	13	12,000	Teeth good—locked
4	12	12,000	Teeth good—locked
7	12½	12,000	Teeth good—locked
8	15½	12,000	Teeth good—locked
3	5½	12,000	Teeth good—locked
3	12	12,000	Teeth good—locked
8	9	12,000	Lubricant added last 4 hours
10	8½	30,000	Teeth worn—bearings good
4	8	30,000	Teeth worn—bearings good
43	7	30,000	Teeth worn—bearings good

This article is adapted from a paper presented at the 1959 Gulf Coast Drilling and Production Practice Meeting sponsored by the Evangeline Section, SPE of AIME, Lafayette, La.



HIGHLY INHIBITED MUD with calcium base is successful in preventing sticking during drilling at offshore Louisiana sites. Fig. 1.

base lubricant has proved valuable in minimizing differential or sidewall sticking. As an example, we have several wells drilled from offshore platforms on the Louisiana coast by the same contractor (see Fig. 1). Well No. 1-A was drilled with a lime-base mud of excellent characteristics. After much hole trouble, the operator finally lost the hole at 13,126 ft.

The operator plugged back and sidetracked the original hole and was able to drill to 14,600 ft. (well 1-B) before he again lost the hole while conditioning prior to running an electric log. The hole was then plugged back to a string of casing at 12,000 ft. and again sidetracked, but at 12,400 ft. the operator decided to quit the second sidetrack hole.

The operator then moved to another offshore location and using a lime-base mud drilled a new hole to approximately 14,700 ft. (well 2). In this well be landed 7-in. casing at 13,500 ft. and ran a 5-in. liner to total depth, 14,700 ft.

Pipe was stuck eight times and casing strings twice as the operator attempted to drill the previously mentioned wells.

New attempt with EP . . . Another attempt to drill to the desired area was scheduled on an adjacent block (well 3). For this attempt, a low-water-loss, highly inhibited calcium mud system was recommended, plus suitable additions of water-base EP lubricants. This program was approved and drilling commenced. At 11,600 ft., ¾ gal of water-base EP lubricant was added per barrel of mud.

Within 24 hours, drilling torque decreased from 175 to 125 amp. After drilling for some 3 or 4 days, the operators reported that they were able to run their bits up to 24 to 26 hours as compared to 12 to 18 hours prior to the EP additive. Bit bearings showed much less wear and teeth were completely worn out after the EP agent was added. In contrast, there was much bearing wear prior to the addition of the EP agent.

This hole drilled to 13,000 ft. and 9⅝-in. casing successfully set. The operator then successfully drilled to the target depth of 16,100 ft.

During the entire operation there was no hole difficulty. The operator estimated that as the result of adding the extreme-pressure lubricant, average bit life had been extended from 30 to 35%. He also estimated that he saved an average of one third to one half trip per day.

Deepen old hole . . . Immediately upon completion of Platform Well No. 3, the operator decided to move back to Platform No. 1 and deepen Hole No. 1C. The same type of highly inhibited calcium mud system was used but only approximately ¼ gal. of EP lubricant was added to the system. By the time drilling reached 13,200 ft., the operator had some hole difficulty. Tight spots were noticed when making trips and one day the pipe was stuck for a period of about 30 minutes.

At this point more water-base EP additive was added to bring the total treatment up to 1 gal. per bbl. After this, lubrication effects immediately improved; within several days all tight spots in the hole were eliminated.

Drilling then continued to 14,600 ft. where 7-in. liner was set. After setting the liner, the well was drilled to the target depth of 16,100 ft. without difficulty.

Lasts longer than expected . . . In these operations we discovered that water-base EP additive has excellent lasting characteristics. On Well No. 3, we had a total of ¾ gal. per bbl. at 11,600 ft. on October 28, 1958. On December 16 an additional ¼ gal. per bbl. was added, not because the EP failed or because increased torque was indicated on the EP tester, but because we could not conceive that any material could persist for so long. This drilling operation continued until January 4 with no further EP additive being added.

On subsequent drilling operations we have found that the initial addition of ¾ to 1 gal. per bbl. of the water-base EP lubricant will last from 4 to 6 weeks without maintenance of any kind.

Table 2 compares the effects of drilling with and without water-base EP lubrication. In this case the same formation (within 40 ft.) was drilled by the same crew with the same equipment. Although the muds were different, previous experience with gyp muds has indicated no lubrication effects per se attributable to this type mud. The lubricant-treated well did show the effect of lubrication by lowering drilling torque and by increasing bit life.

Underlying Theory

The SAE gave the name "Extreme Pressure Lubricants" in 1931 to those lubricants suitable for the severe service in hypoid gears. The action of an EP lubricant is regarded as depending on a chemical reaction at the

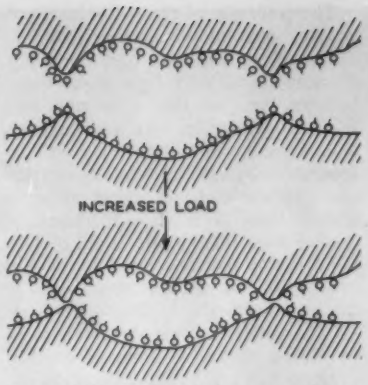
bearing surface. Result of this reaction is the formation on that surface of a deposit such as iron sulfide which has a lower resistance to shear than the metal itself.

The literature on EP lubricants deals almost exclusively with lubricants in which non-polar hydrocarbons are the vehicle. Little of it pertains to establishing lubricant films in aqueous media. In fact, the application of EP lubricants to drilling muds is too narrow a concept to confine our thinking and attention. The whole field of thin film and boundary lubrication in aqueous media is virtually unexplored.

At first, we were not so much concerned with the strict aspects of EP lubrication as with seeking means of providing effective lubrication for highly inhibited drilling fluids. Drilling muds with an inhibition equivalent to 3,600 p.p.m. of calcium in the filtrate induce frictional problems because of their very effectiveness in drilling gage hole. Furthermore, although we could control water loss to less than 1 cc. and maintain low viscosity and low gels in high-weight muds, we still found that we were troubled with torque problems usually referred to as differential sticking.

For these reasons, then, our laboratory undertook to review the whole subject of thin film and boundary lubrication in aqueous media and in particular its surface and physical chemical aspects.

Bearings have high spots . . . The surfaces of bearings are not perfectly plain but consist of microscopic hills and valleys. An adsorbed boundary lubricant acts to keep the metal surfaces apart by virtue of the structure of the adsorbed film as shown in Fig. 2. As load is applied, however, there is plastic flow of the adsorbed film until the area of contact is large enough to support the load. As the load increases, the adsorbed film is subjected to higher and higher pressures at the high points until local breakdown occurs resulting in metallic adhesions at that point.



ADSORBED FILM of lubricant keeps metal bearing surfaces apart. Increased load brings metal surfaces closer together. Fig. 2.

The extent of this breakdown depends on the nature of the lubricant film. At the high points where pressures are greatest, temperatures may be quite high. It is primarily on these high-point areas that the reaction products referred to as EP lubricants come into play. In the case of iron, suitable EP agents form iron chlorides or iron sulfides at these points of metallic contact. These reaction products have less resistance to shear than that of the metal and yet do not break down chemically under local high temperatures.

The coefficient of friction of the iron chlorides is less than that of the iron sulfides. However, iron sulfides remain effective barriers to metal-to-metal contact at much higher pressures, as would be expected on the basis of physical properties of iron chloride and iron sulfide.

The increasing frictional force with increasing bearing pressures is a result of the partial breakdown of a lubricant film and formation of metallic junctions between the bearing surfaces. The resistance to motion, therefore, consists partially of the force necessary to break these junctions as well as overcoming some of the viscous friction of the lubricant film itself.

The frictional force of lubricated surfaces has been expressed as follows:[2]

$$F = A[\partial S_m + (1 - \partial) S_l] \quad (1)$$

where:

A = The area which supports the load.

∂ = A fraction of this area over which breakdown of the film has occurred.

S_m = The shear strength of the junction at metal-to-metal contact.

S_l = The shear strength of the lubricant film.

The main function of a lubricant, then, is to reduce the amount of intimate contact between surfaces. It does this by forming a film that is not easily penetrated and which has relatively low shear strength.

Lubricant adhesion needed . . . To prevent appreciable metal-to-metal contact the lubricating layer must firmly attach to the metal surface and have high viscosity or consistency. It would seem that the lateral adhesions of the lubricant molecules as shown by viscosity are at least as important as their strength of attachment to the surface. Reason is that the more viscous the film the greater will be its resistance to being extruded at the points of high pressure as load on the bearing increases.

This point is substantiated in the literature of lubrication. For example, liquid long-chain alcohols which are highly polar and well adsorbed at the metal surface are worse boundary lubricants than the solid paraffins which are only weakly adsorbed at the metal surfaces. When these solid paraffins are melted, however, the lateral adhesion of the molecules falls and there is metallic welding between the metal surface with a corresponding increase in friction and wear.

This effect is shown again in the lubricating properties of fatty acids. On nonreactive metals such as platinum or gold they are hardly more effective than alphatic hydrocarbons. But, suppose they are applied to surfaces with which they can react, i.e., iron. They form a film of metallic soap, the molecules of which do have strong lateral adhesions as well as a melting point in excess of the pure acids. This resulting film provides more effective lubrication and a higher temperature than can be obtained with the fatty acids alone.

Because of the high lateral cohe-

TABLE 2—OPERATING EXPERIENCE IN COMPARISON INTERVAL PLATFORM NO. 1 OFFSHORE LOUISIANA

Comparison in sidetrack holes from same platform, with same crew, and same equipment, same drilling contractor, and same mud service company.

Well—	1 (B)	1 (D)
Footage drilled in comparison interval	2,272	2,236
Number of bits	36	32
Rotating time, hours	775	730
Mud—Type	Lime	Highly inhibited calcium.
Weight, lb./gal.	15.5	15.5
Weight on bit, lb.	18-20,000	18-20,000
Rotary speeds, r.p.m.	45-75	45-75
Cost of lubrication (total for well)	....	$2,800
Saving in trip time	....	$8,000
Final result	Stuck pipe	Continued drilling 1,500 ft. to a successful completion.

sions of the soap molecules, the soap films have semiplastic flow characteristics. They can stand much deformation without rupture of the films. Consequently these organometallic soaps are widely used as lubricants.[3]

Above softening point . . . These soap films maintain their lubricating properties until their softening point is reached. After this, the soap film loses its lateral cohesion characteristics and, in addition, its linkage to the metal surface grows weaker. Breakdown of the lubricant film is usually accompanied by the solution of the molten soap into the superincumbent oil or excess fatty acid.

Metallic soaps at higher temperatures form a pseudoplastic or viscous film at bearing clearances well below those at which hydrodynamic lubrication might be expected to begin. As a result, the conditions are no longer those of true boundary lubrication, and friction and wear may diminish.[4]

Oxide film necessary . . . There is indication that lubrication by fatty acids is due to the formation of a metal soap as a result of chemical action on metal surface. Experiments on the corrosion of metals in solutions of fatty acids and hydrocarbons[5,6] show that this reaction takes place via an oxide film. A 1% solution of lauric acid in paraffin oil, for example, is no more effective in lubricating a metal surface that is free of any oxide film than in paraffin oil itself.[7] Aging or increasing the temperature will not improve the lubrication.

If, however, the tests are repeated on surfaces with an oxide film, good lubrication is obtained. These facts gave strong additional evidence that formation of a soap film is necessary for effective lubrication by fatty acids in paraffin oil. And, with dilute solutions of fatty acids, soap formation is favored by presence of water as well as an oxide film.

Metal surfaces which are freshly cut or exposed under oil are difficult to lubricate effectively by fatty-acid solutions. This fact is of interest to us. Where metal surfaces slide one on the other in the presence of a hydrocarbon film, the abrasion of the surfaces through the oil film may expose portions of metal free from surface oxide. These portions may not be readily lubricated by the fatty acids in the oil unless oxygen and water are present. Consequently, in aqueous systems the presence of surfactants that promote oil wetting of metal could actually be detrimental to the formation of fatty-acid lubricant films.

The principle of the oxide layer, of course, introduces another complication. Even with the best boundary lubricants and very light loads there is some wear of the underlying surfaces once sliding has commenced; and, some of the oxide layer will be eroded away in friction. Now this oxide debris may act as an abrasive and increase wear if its hardness is greater than that of the metal.

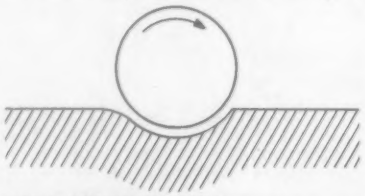
Or it may reduce wear if it is softer than the metal. On the other hand, if the oxide debris is of the right physical characteristics it may reduce wear by filling up the hollows of surface irregularities and thereby decrease the areas of high pressures and temperatures by increasing total contact area.

Applying to aqueous media . . . These facts were found in connection with the mechanism of lubrication in hydrocarbon medium. But they do give us indirect information on what is needed in lubricants for aqueous media.

For example, there are several things we can conclude if we are to formulate a satisfactory lubricant for aqueous media.

- It would appear that the basic material should be one that reacts with, or is highly adsorbed upon, a metal surface.
- The rheology of the adsorbed material would be classified as a plastic or pseudoplastic with a high yield point.
- The reaction complex must maintain its identity throughout the temperature range of its application, i.e. the softening or melting point should not be too low.
- The lubricants should not be soluble in water, and if oils are to be used, they should also be insoluble in oils.
- They should not be subject to hydrolysis or their degradation reactions in an aqueous media and should not have any adverse effects upon other ingredients of a mud system or the properties of the mud.

We have found certain reaction complexes which satisfy these requirements. They are derived from saturated and unsaturated carboxylic acids of sufficiently high molecular weight.



HARD ROLLER BEARING moving on a race causes slight indentation of the race surface as bearing moves along. Fig. 3.

We have investigated the lower-molecular-weight crude fatty acids such as are present in tall oils. They do not provide what we would term adequate performance. This is likely due to the lower melting points of these fatty-acid compounds as well as to their high solubility in oil. The freshly precipitated neutral soaps of most of the common metals of the tall oils are usually fluid at the boiling point of water. Consequently, they may not be expected to provide adequate lubrication at normal drilling temperatures.

Lubrication of rollers . . . So far, however, we have considered only sliding friction. If, however, in the lubrication of drilling muds, we want longer bit life, we must extend our thinking to roller bearings.

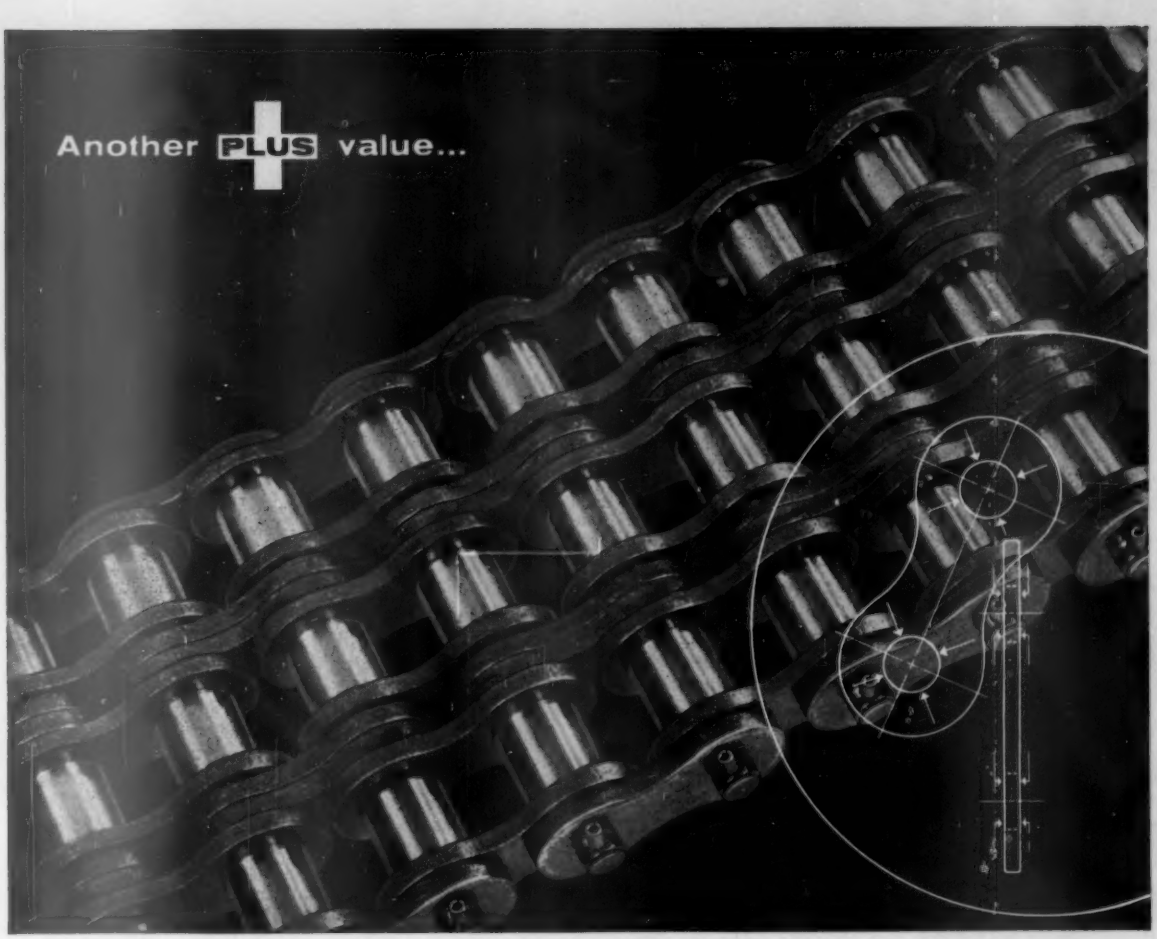
Fig. 3 represents an idealized state of a hard roller bearing moving on a race. We see that there is an indentation of the race surface as the roller bearing moves along. The degree of recovery of this indentation is a function of the elasticity of the metal. The most effective roller-bearing lubricant would be one in which the resistance to shear increased markedly with increased shear. Such characteristics would minimize squeezing out of the lubricant in the indentation area.

Consider bit-bearing life and the mechanism of bit-bearing failure. It is immediately evident that we must consider factors other than those concerning sliding friction. If we examine the roller bearings in bits, we almost never find the characteristics of metal-to-metal seizure. On the other hand, there is almost always pitting, spalling, and metal cracking. These are evidences of corrosion and not friction.

In air drilling, bit life normally exceeds, by several fold, life of bits used in aqueous media. If there are water flows while drilling with air, the bearings are temporarily exposed to an aqueous environment. And bearing life usually falls off drastically. It would appear, therefore, that there is something about a water environment that greatly shortens bit life.

Problem is corrosion . . . This line of questioning leads one directly into the field of corrosion, stress corrosion, and metal embrittlement. In the study of corrosion in aqueous media it is well known that oxygen, sulfides, chlorides, and caustics are characteristically troublesome.

In Fig. 2 we can see that there is a continual working of the metal inner bearing race. Crystalline dislocations are continuously repeated. Result may be a certain degree of un-



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bonding of the metal surface which would serve as a site for the beginning of intercrystalline or transcrystalline corrosion. At the same time, there is tremendous work put upon any foreign material in the bearing race. This could start reactions resulting in the formation of nacent hydrogen. A case in point would be the formation of hydrogen by proton liberation at freshly fractured clay surfaces in aqueous media. In some circumstances, this reaction could be a potent source of hydrogen, sufficient for hydrogen embrittlement even in alkaline fluids.

The formation of the typical EP lubricant film is the product of a controlled corrosion process. For this reason we must keep in mind all aspects of corrosion when searching for suitable lubricants for water-base muds.

To prevent embrittlement . . . For example, certain sulfur-containing compounds may be feasible EP agents in nonpolar or hydrocarbon media. It would not matter that these compounds undergo thermal decomposition at the point of high pressure giving acidic reactions which form an iron sulfide. On the other hand, it might be inadvisable to attempt to produce similarly an EP sulfide surface in an aqueous media. Such a thermal degradation in aqueous media could result in the formation of hydrogen sulfide. In water, H_2S forms a weak acid which can attack steel surfaces and thereby release hydrogen:

$$Fe + H_2S \rightarrow FeS + 2H \rightarrow FeS + H_2$$

The H_2S "poisons" the surface available for recombination of atomic hydrogen into molecular hydrogen. It acts as a promoter for the entry of atomic hydrogen into steel.[8] This reaction could occur at the points of high-pressure contact even in a nominally alkaline environment.

The sulfide reaction in an aqueous media could provide EP effects from the standpoint of preventing metal-to-metal contact. However, wear in such cases may be greater than normal because of the weakening of the hydrogen sulfide-contaminated surfaces. Long-term effects might result in embrittlement.

So, because of the danger of embrittlement, we had to discard forming a sulfide, phosphide, or chloride corrosion film at the metal surface as a basis for EP film. Other means had to be sought as the basis for an aqueous EP agent.

Oxide film passes . . . The widespread use of fatty acids in lubricants indicated that these compounds or compounds derived from them might still provide an effective lubricant for aqueous media. Recall, however, that we have pointed out that the fatty acid reaction at metal surfaces takes place via an oxide film. We must therefore, consider oxygen corrosion.

There is some evidence that oxygen is able to play a role in lubricated surfaces. Further, under certain conditions, oxide films may act as EP lubricants.[9]

Moreover, oxygen corrosion of iron is not usually associated with embrittlement. On the other hand, under proper conditions an oxide film may be formed that protects the metal surface from further corrosion. The passivation of iron is due to a film of magnetic oxide of iron.

This protective oxide film can be varied if it takes place in presence of sulfates or oxides of various metals such as cobalt, manganese, or chromium. The protective oxide film in these instances contains the oxides of these metals in addition to iron oxide. These metal components alter the rate, extent, and character of oxide film formation.[10]

It appears feasible, therefore, to establish lubricant films coupled to iron surfaces by means of monomolecular iron oxide films. This would require a suitable aqueous environment to promote formation of magnetic oxide film.

The new EP lubricant is based upon these considerations. This drilling mud lubricant was formulated to provide effective EP lubrication at the operating temperatures of Gulf Coast muds.

Testing Procedures

Obviously, to evaluate additives useful in promoting lubrication in water-base drilling muds requires broader testing procedures than a friction test. We are concerned with corrosion and embrittlement phenomena as well as lubrication. However, we feel that inasmuch as we are attempting to lubricate in aqueous media, this lubrication should have EP properties, i.e., provide lubrication at 100 lb. Timken or its equivalent.

We do feel, however, that these tests should be in line with use requirements. That is, the lubrication should be provided for the speeds and the temperatures that actually exist in drilling. We do not feel that adequate lubrication protection is given by additives that do not operate efficiently at 212° F., or at pressures less than 80 lb. Timken or equivalent.

In weighted muds, the suspended barite itself is a sufficient barrier to prevent complete metal-to-metal contact under high pressures. Referring to Equation 1, we see that in such instances the frictional force indicated by the power input to the testing machine, or the torque created by the friction, is the most reliable indication of lubricant effectiveness. When the lubricant is added to a drilling mud, it should always decrease the sliding friction. Maintaining the sliding friction at some low level is a convenient method of showing the presence and adequacy of a lubricant.

Good for field check . . . The Baroid EP tester, we believe, is a convenient field means of evaluating the lubricant treatment. We have found that weighted muds will not "seize" or "fail" in the tester but that the friction as indicated on the ammeter will be high, i.e., 6 amp. or more. With a suitable EP lubricant at 450 in.-lb. pressure on the tester, the friction will be reduced to 4 amp. or less.

It is important that those tests be made at operating mud temperatures. The heat at the friction points is not determinative in the systems, for we have found both friction and wear as well as actual EP lubrication to be affected by the temperature of the mud in the test cup.

For development purposes then we believe that temperature control, controlled variable speed, and sensitive measurement of frictional torque, are as necessary as variable friction loading. An instrument is under development to fulfill these requirements.

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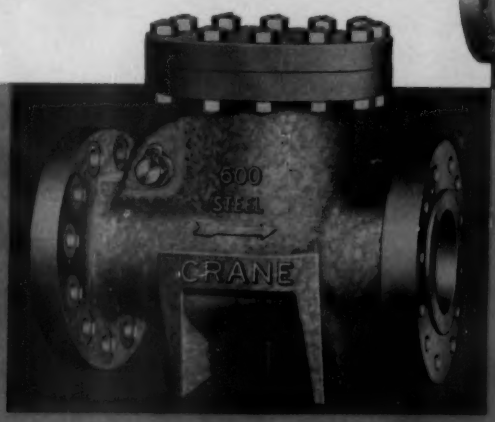

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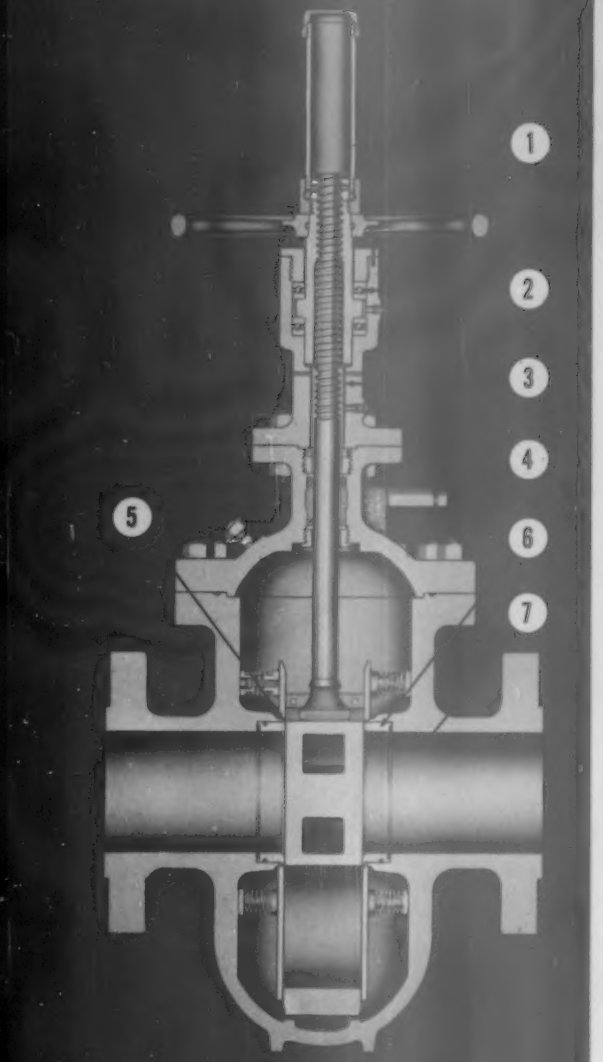

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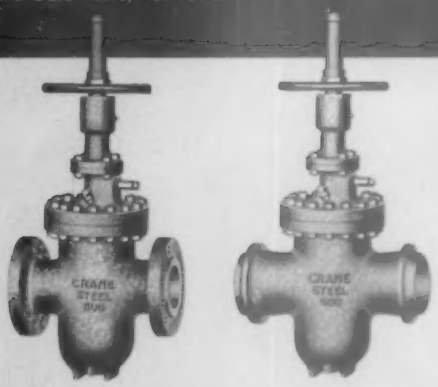

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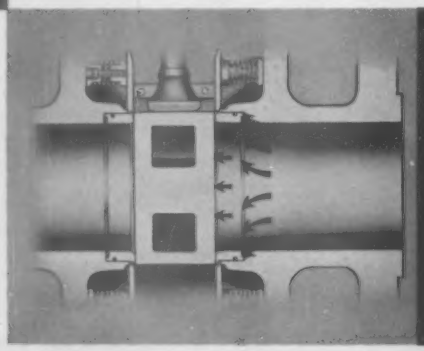

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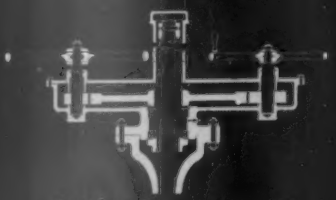
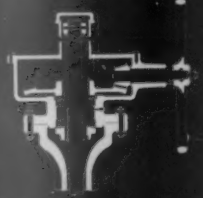
Dual Bevel Gearing—side view

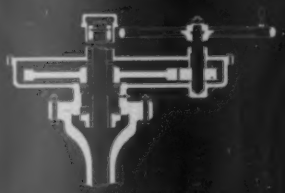
Dual Bevel Gearing—top view



Dual Spur Gearing—side view



Single Bevel Gearing—side view



Single Spur Gearing—side view

GEARING RECOMMENDATIONS

For conduit type valves—full-way and venturi. *Class 400:* 14" seat opening and larger—spur or bevel gearing; 26" and 30"—dual spur or bevel gearing. *Class 600:* 10" seat opening and larger—spur or bevel gearing; 22" seat opening and larger—dual spur or bevel gearing.

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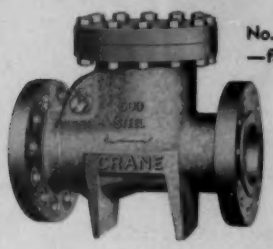
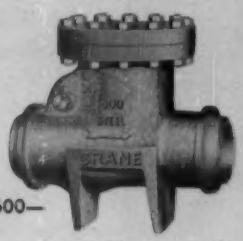


No. 1640—Class 600—flanged ends.

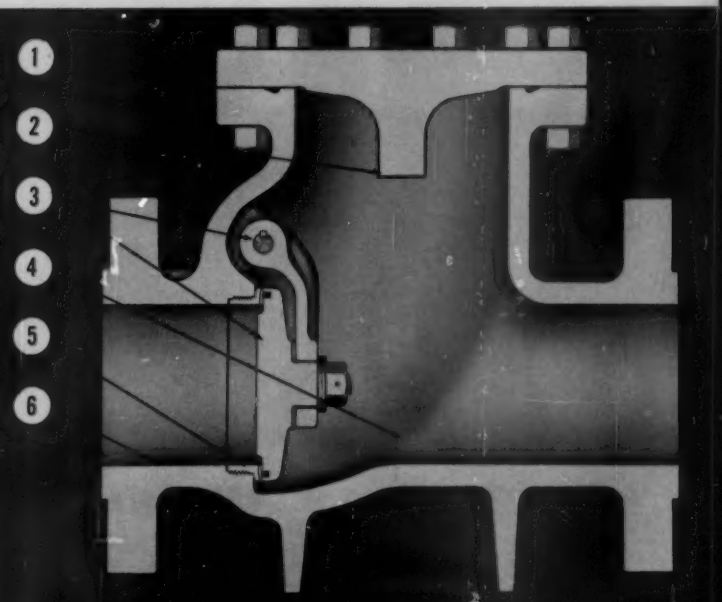


No. 1641—Class 600—welding ends.

Both valves available in ten sizes—4" to 24". Working pressure: 1440 psi at atmospheric temperatures. *Service recommendations:* crude oil, gas or finished products. Comply with applicable standards as listed by ASA and API.

NOTE THESE HIGH EFFICIENCY FEATURES—

1. **Bolted cap joint**—synthetic rubber "O" ring gasket assures tightness.
2. **Disc stop**—prevents disc from sticking in open position.
3. **Clearway disc**—swings clear of fluid way. Synthetic rubber disc insert provides "soft", tight seating. Stainless steel hinge pin swivels in Teflon sleeve bushings.
4. **Clearway interior body design**—permits virtually straight-line flow; shallow cavity allows free passage of scraper.
5. **Shoulder-type, screwed-in seat ring**—Stellite-faced; can't loosen in service.
6. **Port and seat opening**—are full diameter of pipe for smooth flow-through.



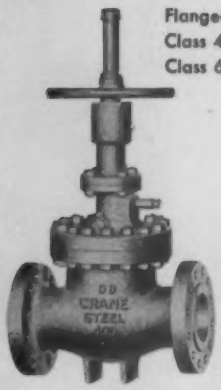
Cross section of Clearway swing-check steel valve.

CRANE DOUBLE-DISC PIPELINE GATE VALVES

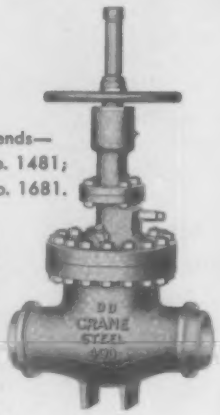
Classes 400 and 600—for all services

Features that mean worry-free service and reductions in valve maintenance and replacement costs are built into these new Crane steel pipeline valves. These features include:

1. **Free-to-rotate discs,** with outer rims that take the wear usually borne by the disc face.
2. **Guided disc action**—guide ribs in body, machined to close tolerances, prevent disc drag across the seat; give smoother operation.
3. **Positive seating**—unique wedging action of spreaders forces discs outward for tight contact with body seat rings.
4. **Fully enclosed yoke**—partially grease-filled—lubricates stem and threads.
5. **Plastic packing** easily added here, with valve on full line pressure—disc in any position.
6. **Pressure relief valve**—relieves excess pressure built up by outside temperature changes.
7. **Smooth,** straight passageway eliminates turbulence . . . assures smooth flow.

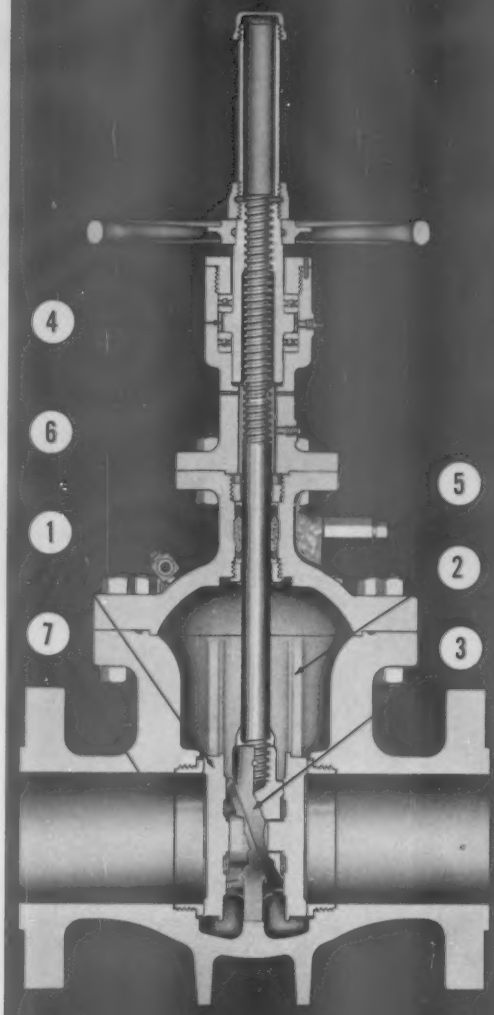


Flanged ends—
Class 400, No. 1480;
Class 600, No. 1680.

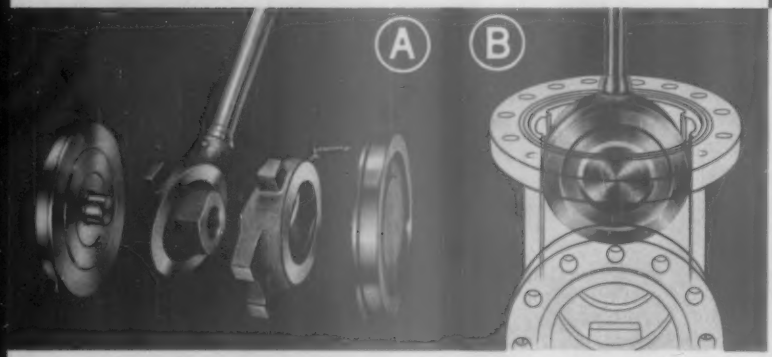


Butt-welding ends—
Class 400, No. 1481;
Class 600, No. 1681.

Both patterns OS&Y. In ten sizes: 4" to 24". Pressure Ratings: Class 400, 960 psi; Class 600, 1440 psi — both at atmospheric temperatures. All valves recommended for crude oil, gas or finished products. MATERIALS: Body, bonnet, yoke—cast carbon steel.



Cross section: Crane Double-Disc, Parallel Seat Pipeline Gate Valve.



Free-to-rotate discs. (Illus. A) Outer rims (arrow) take the wear. Both discs, independently suspended, are free to rotate as they move up and down in body guide ribs. Wear is uniform. Rotating action tends to clear seating area of abrasive materials. Discs are easily replaced.

Guided disc action. (Illus. B) Guide ribs in body, machined to close tolerances, provide easier, smoother seating. Tapered slightly at the top, ribs hold disc assembly snugly in open position—yet in closed position allow full wedging action of spreaders.

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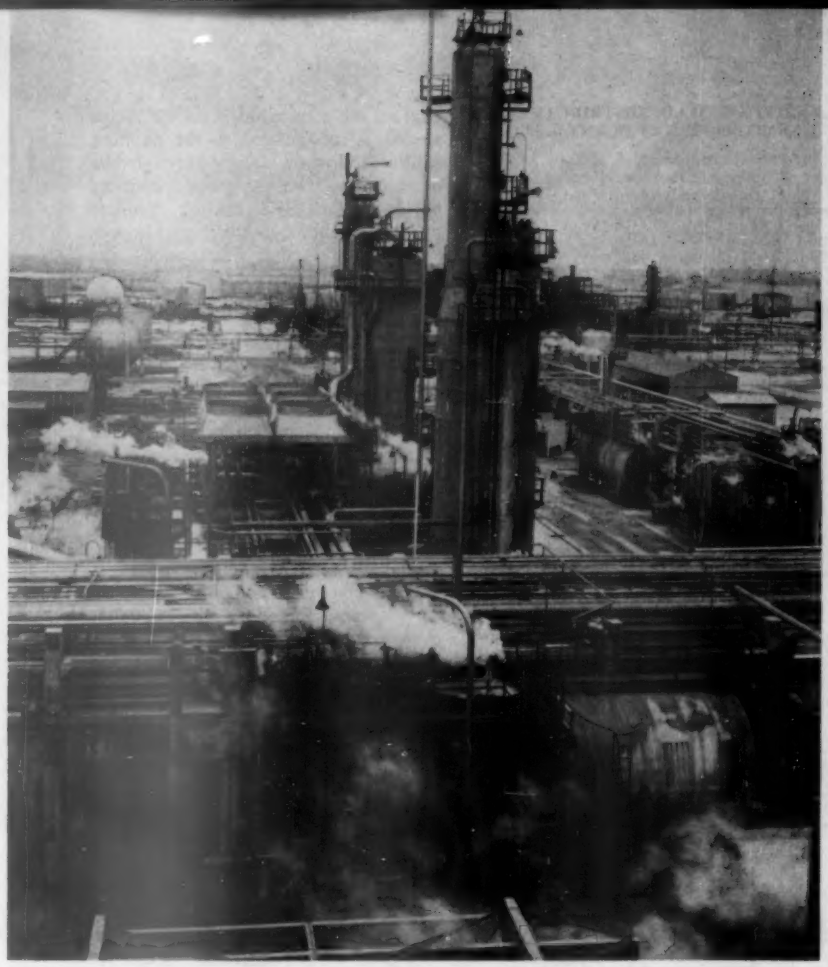


UNSATURATE STREAMS are handled in this plant.

OPERATING REPORT: Standard of Ohio's

Dual gas-recovery system

"... permits alkylation plants to operate at high rates without the hindrance of superfluous amounts of nonreactive normal butane."

BY LARRY RESEN
Refining Editor

A DUAL gas-recovery system at the new Toledo refinery of Standard Oil Co. (Ohio) has been living up to expectations. The two sections in effect provide segregated gas-recovery facilities, keeping the saturate and unsaturate gas streams apart. Prime object of the design is to recover alkylation-plant feed streams which will have a low normal butane content.

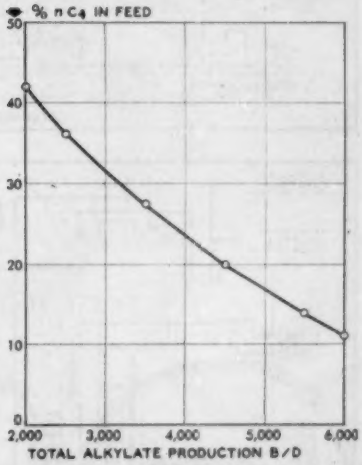
The facilities include a high-capacity deisobutanizer in the saturate section which is also tied into alkylation-plant operations. Net result has been to permit the alkylation plant to operate at high rates without the hindrance of superfluous amounts of nonreactive normal butane.

The presence of n-butane in the alky unit feed has a depressing effect on unit operations. By taking up room in the process stream which could be used by reactive materials, it effectively limits reactor capacity. By throwing an additional load on the fractionation train, n-butane again tends to hold back capacity. A change in the n-butane concentration from 10-11% of the feed to around 23-24% will decrease unit capacity from 6,000 to 4,000 bbl. daily.

Diversion of the saturate streams to one gas plant has effectively concentrated most of the n-butane make of the total refinery in this facility, thereby cutting down the amount which takes a "free ride" through the alkylation unit. The n-butane product from the saturate gas plant runs about 3,200 bbl. per day. However, only about 475 bbl. per day of n-butane enters the alkylation plant along with isobutane and butylenes from the unsaturate unit (Tables 1 and 2).

Saturate feed . . . The saturate gas plant receives its feed from four sources: the overhead product from the reforming section debutanizer; the hydrogen-rich excess make gas from the reformer; hydrogenation-section effluent; and alkylation-unit butanes.

The unsaturate gas plant receives its feed from three sources: gas from the fluid catalytic cracking section fractionator; extraneous gas from the crude section; and extraneous gas from the coking section. The liquid from the fractionator's overhead accumulator is split into two streams. One returns to the fractionator as reflux, the other serves as absorption oil in



"A change in the n-butane concentration from 10-11% of the feed to around 23-24% will decrease unit capacity from 6,000 to 4,000 bbl. daily."

TABLE 1—YIELD DISTRIBUTION OF SATURATE GAS PLANT (Bbl./Day)

	Deisobutanizer overhead	Deisobutanizer bottoms	Propane	Light naphtha
C_2	0	0	0	0
C_3	2	0	671	
iC_4	678	3	17	
nC_4	23	3,191	1	20
iC_5		139		443
nC_5				1,150
C_6+				1,300

Dry gas	Mole %	Dry gas	Mole %
H_2	88.5	iC_4	0.2
C_1	5.7	nC_4	0.3
C_2	3.0	iC_5	tr.
C_3	2.2	H_2S	0.1

TABLE 2—YIELD DISTRIBUTION OF UNSATURATE GAS PLANT (Bbl./Day)

	Depropanizer overhead (to poly)	Depropanizer bottoms (alky feed)	Lt. cat. dist.	Hvy. cat. dist.
C_2	20			
$C_2^=$	1,350	81		
C_3	785	40		
iC_4	89	1,340	2	
$C_4^=$	25	1,950	2	
nC_4		475	1	
iC_5		36		
C_5		10	1,900	
C_6+			5,500	7,700

Dry gas	Mole %	Dry gas	Mole %
H_2	12.3	$C_2^=$	3.6
N_2	8.2	C_2	16.2
CO	11.5	$C_3^=$	0.8
H_2S	0.8	C_3	0.2
C_1	46.0	C_4	0.4

the absorber-stripper tower. This gasoline stream with absorbed light ends passes through the debutanizer and C_3-C_4 splitter before entering the gasoline splitter. This tower functions to provide the plant with a light and heavy catalytic gasoline product.

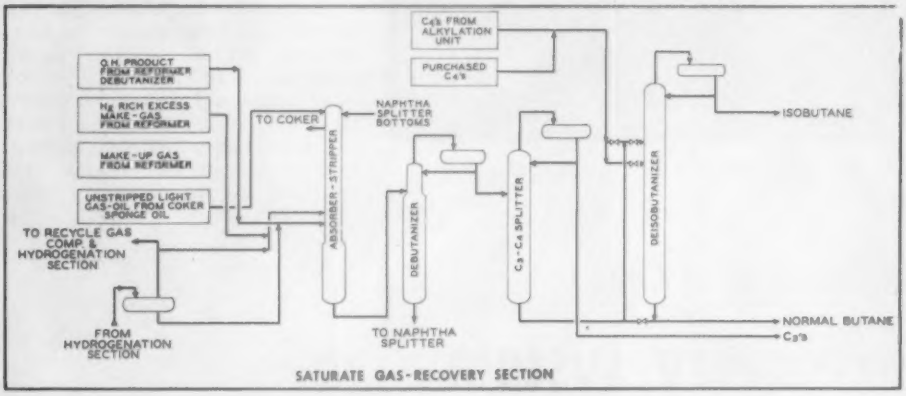
Alkylation plant feed is recovered from the bottom of the C_3-C_4 splitter with overhead going to the cat poly section. A stream from the poly unit depropanizer bottom is recirculated to the gas recovery section and enters the process upstream of the debutanizer. This recycle helps to conserve isobutane, since some of it ends up in the feed to the polymerization plant. It is returned to the recovery system in this manner and subsequently ends up in the alky feed stream.

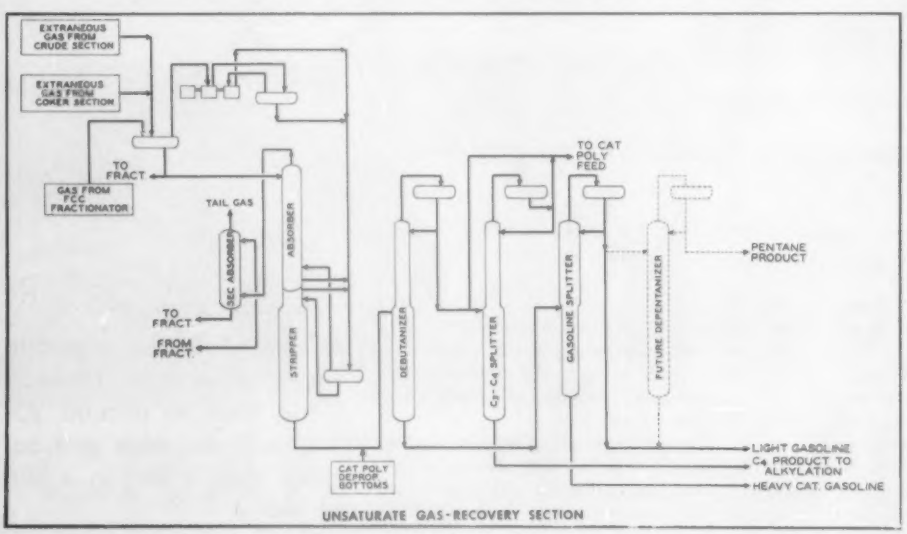
In the flow through the saturate gas-recovery section, naphtha-splitter bottoms from a catalytic reforming section serve as absorption oil. This stream is recirculated to the naphtha splitter following a pass through the debutanizer. The gas plant produces normal butane and propane products plus an isobutane product. An important feature is the high-capacity deisobutanizer which has a bearing on alkylation-plant operations.

Isobutane expensive . . . Isobutane is an expensive commodity, especially in this area far removed from Southwest producing regions. Hence, the entire gas-processing scheme is designed to recover essentially all of the isobutane in the various process streams in the refinery. About 98% of usable i-butane is thus realized from the total available.

The alkylation-plant deisobutanizer is relatively small, and in itself would be a limiting factor on unit capacity. However, the n-butane cut is sent to the deisobutanizer in the saturated gas-recovery unit. This acts somewhat as a second-stage tower for the alky plant. From a quality standpoint it's better to operate the alkylation plant's deisobutanizer so as to let some of the isobutane out with the spent butane. The former is then recovered in the gas-recovery section.

The main deisobutanizer also receives purchased butanes in its feed stream. With the capacity available, it's possible to purchase marginal butane stocks with a low concentration of isobutane. The latter can then be recovered and used in the alkylation plant. Looking to the future, the concentration plant is also readily adaptable to butane isomerization should this become necessary with increasing alkylation capacity.



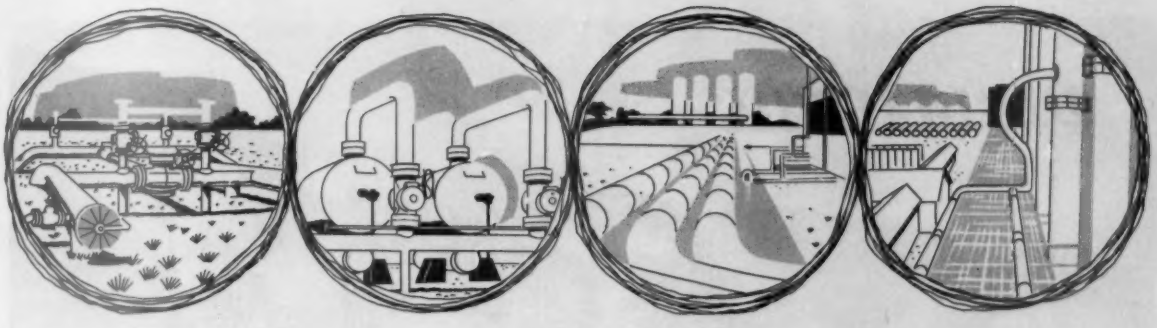


Acknowledgment

The cooperation and assistance of W. L. Vermilion, Jr., of Standard Oil Co. (Ohio) in the compilation of data for this article is gratefully acknowledged.

Reference

"Dual Gas-Recovery System Is Used," The Oil and Gas Journal, June 23, 1958, p. 103.



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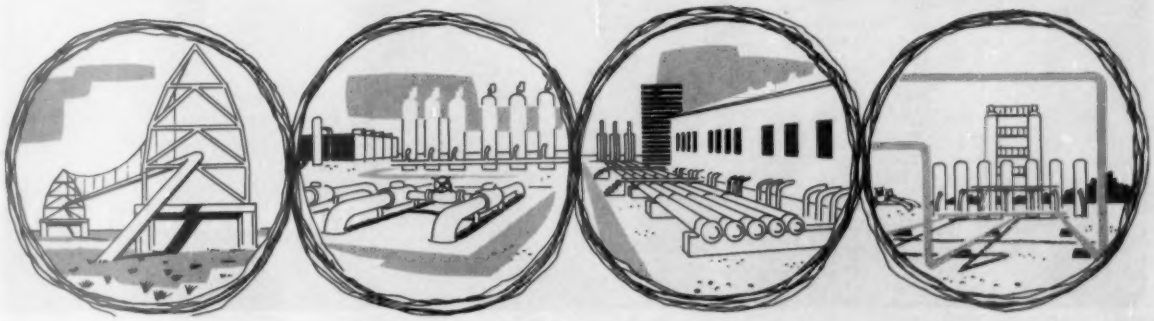

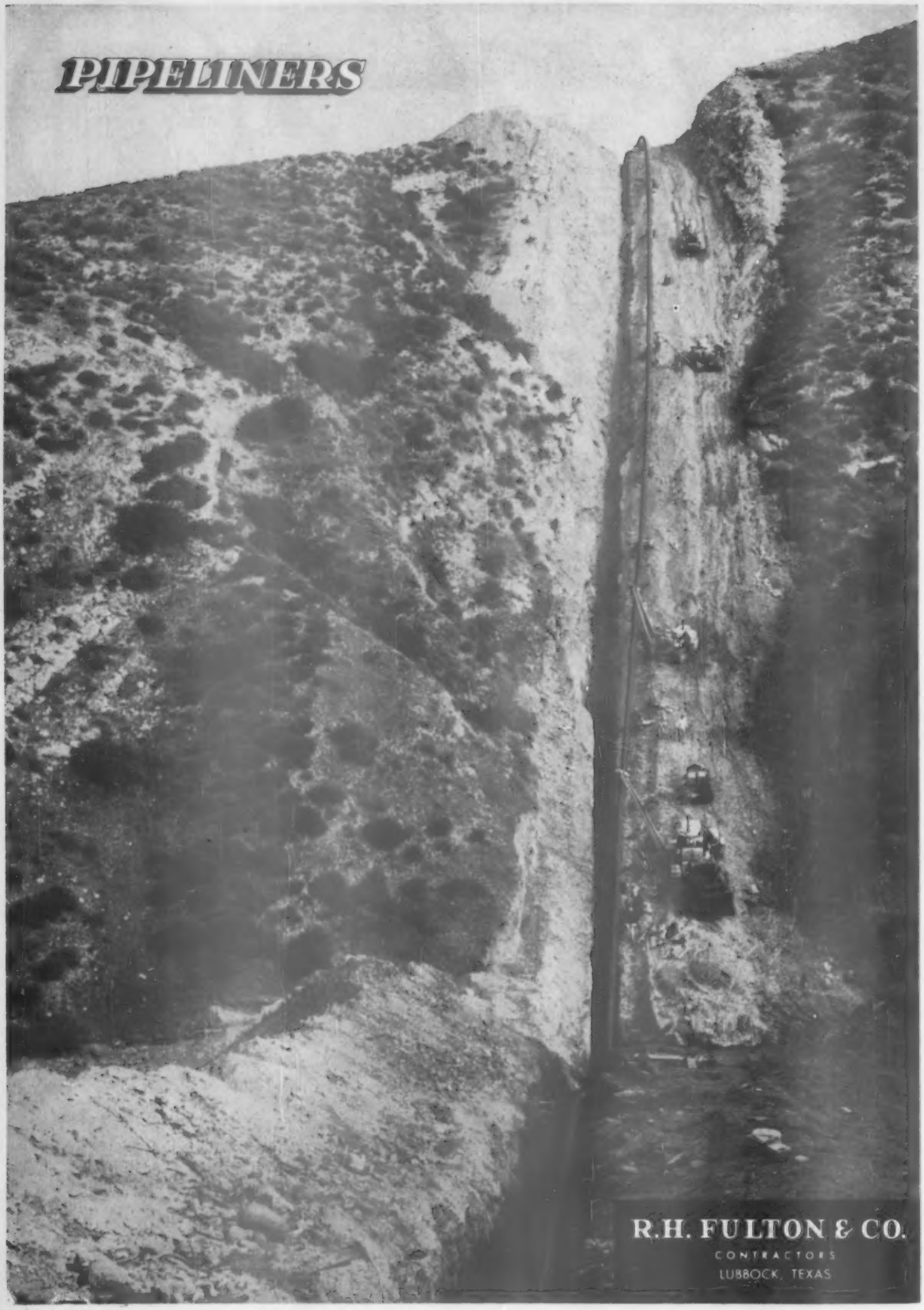
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On the Job

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Here's how one company uses

RADIOISOTOPES

for interface detection

BY C. W. BLACKBURN
Technical consultant,
Phillips Petroleum Co.

SEVERAL makes and several types of interface detectors are being used by Phillips for various applications.

Although detectors using radioisotopes will be stressed, I would first like to mention a few other types we are using. This will serve to emphasize certain factors which should be considered in the selection of equipment for various interface-detection jobs. No one type is best.

Dielectric-Constant Instruments

In our product terminals where large cavern facilities have been made in salt formations, we use several makes of detectors to sense the passage of the interface between salt water and propane or other hydrocarbons. In these instruments, the change in dielectric constant of the product as the interface passes produces a change in capacitance in a probe.

This change in capacitance is then sensed by an oscillator circuit, changing the level of oscillation. The change of flow in current in the plate circuit of this oscillator energizes a sensitive relay and pilots an alarm relay. In these cases the interface passage causes an alarm to sound and a light to come on to alert the operator.

Fig. 1 shows installation of a dielectric-constant-type detector at a pipeline terminal. This is used to detect the interface between water and gasoline (or other finished products).

An alarm light will come on when the interface passes the probe. In some cases we have an audible signal in addition to the light. The alarm contacts could, of course, be used to perform automatic-control functions directly. But since these are for emergency alarms, which very seldom occur, automatic control was considered uneconomical.

Fig. 2 is an example of another series of cases in which we use interface detection. The problem here is to detect the passage of LPG and change the pump-station suction-pressure controller set pointer to a preset higher position. The sensitivity requirement of this instrument is quite critical because the spread of dielectric constants handled by these lines varies only slightly—about 1.600 to 2.100. The last dielectric-constant instrument to be mentioned here is one which facilitates cut-point selection between tenders of crude oil.

Fig. 3 shows the in-line probe installed in a 3-in. bypass line and the explosionproof enclosure which houses the measuring bridge circuits. This particular make has a concentric pair of cylindrical plates comprising the capacitor, with the fluid flowing through the annular space.

The bridge output is fed to an amplifier and recorder. By watching the recorded chart, the operator can determine his cut point. An interesting variation of this system uses a two-pen recorder, with one pen responding to measurement of fluid dielectric constant some distance upstream, the other pen indicating the same measurement at the station.

This arrangement allows the operator to observe the shape of the approaching interface, and allows him time to make a more accurate cut than is possible with a single detector. Phillips has developed dielectric-constant instrumentation for use on automatic - custody - transfer systems which have proved to be very successful in the handling of crude oil.

Properties of Radioisotopes

Here are some properties of radioisotopes:

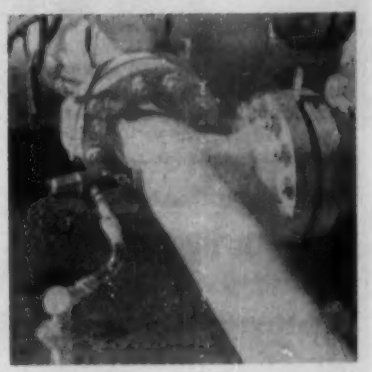
1. All radioisotopes are unstable isotopes (and vice versa), constantly disintegrating. Some radioactive isotopes decay progressively into several unstable isotopes before they become stable. Over 40 radioisotopes occur in nature and several hundred are made artificially.

2. They can be detected in extremely small quantities. For example, a millicurie of cesium-137, the kind we are using for interface detection, occupies a volume of less than 1 cc. and emits gamma radiation at a rate of 37,000,000 disintegrations or "counts" per second. Instruments are commercially available which will detect as few as a dozen or so counts per second.

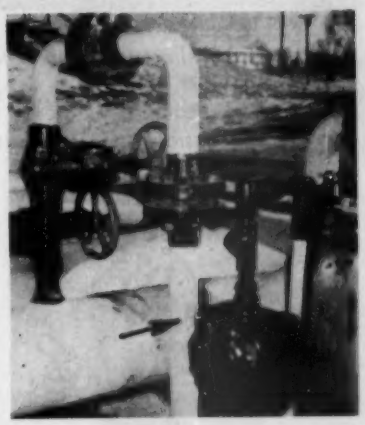
3. This "count" rate decreases inversely as the square (approximately) of the distance from the source. These

From a paper presented before University of Oklahoma Automatic Control Conference, Norman, Okla.

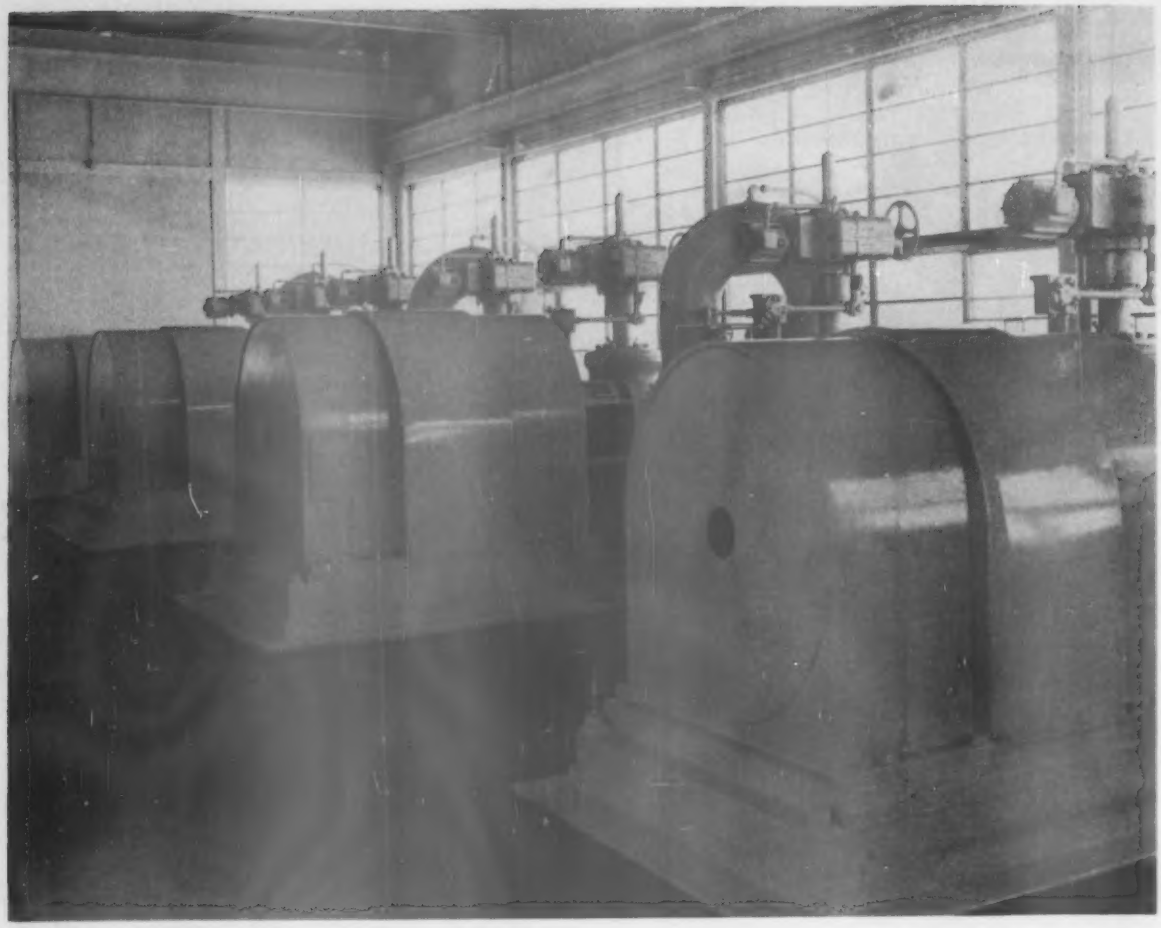
DIELECTRIC-CONSTANT type of interface-detector probe installation at a products-pipeline terminal. Fig. 1.



SPREAD of dielectric constants handled by this detector varies only about 1.600 to 2.100. Fig. 2.



AT CRUDE pipeline station, this type of dielectric-constant type of interface detector probe is installed. Fig. 3.



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materials are commonly rated in half-life, or the length of time which elapses while the source strength decays to one-half of its original strength. For example, cesium-137, with a half-life of 33 years, emits gamma rays at a rate which for all interface detection purposes, can be considered constant. Other radioisotopes such as sodium-24 lose their strength in a few minutes or hours and are useful for short-time measurements and those in which there may be certain exposure dangers.

4. A property which is especially important in interface detection is the fact that all matter absorbs radiation. This fact was publicized rather widely recently when certain citizens expressed alarm at the increasing quantity of strontium-90 detected in the bodies of Americans. Fallout from atomic bomb tests has spread out over wide areas of our grazing lands; cows eat the grass, people drink the milk, and the bones of these people retain the strontium-90. This radioactivity is expected to be retained in the body for 40 years. In interface detection the radioactivity is absorbed by the stream as well as by the pipe or vessel walls.

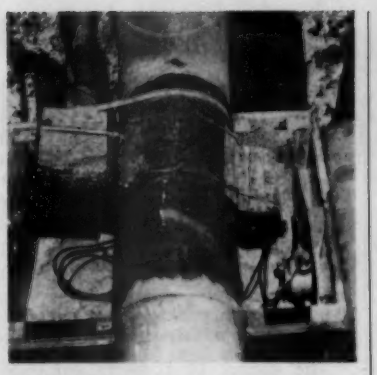
5. Although cost of radioisotopes cannot be considered a property, it is an extremely important characteristic. Costs vary rather widely; for example, a curie of cesium-137 costs about $10; iodine-129 costs $50 for one-tenth of a millionth of a curie.

Application of Radioisotopes

In one pipeline terminal handling crude oil, natural-gas liquids, and 12-lb. natural gasoline, we use a system to detect interface passage in which the instrument measures the change in the amount of radioactive energy penetrating the product.

One good feature of this system as shown in Fig. 4 is that all the required equipment is mounted externally, on or near the pipeline. This allows easy installation and simplifies maintenance. Thermal insulation and a thermostatically controlled resistance-heating element serves to maintain a somewhat uniform temperature around these elements, although the temperature-regulation requirement for this kind of cell is not very critical.

A small capsule of cesium-137 mounted in a sealed can is strapped to the pipe. This capsule emits a constant stream of gamma radiations of relatively low energy (0.662 mev.).



GAMMA-RAY type interface detector is used for this crude-oil and unfinished-products pipeline. Fig. 4.

On the other side of the pipe, diametrically opposite the cesium capsule, is the measuring cell which converts the radioactive energy it receives directly into electrical energy. This cell is a gas-filled can with concentric electrodes and is so designed that the gas is ionized in proportion to the gamma radiation entering it.

This ionization produces a small electrical signal which is then amplified, and fed as a positioning signal to a recorder pen. The strength of the cesium is chosen to provide the desired sensitivity and stability. Part of the radiation is absorbed in the pipe walls, part is scattered around, part is not detected because the measuring cell is not 100% efficient, part is absorbed in the liquid, and part is detected by the measuring cell.

Thus, the change in density of the liquid causes more (or less) radioactive energy to be absorbed, and therefore the remaining amount of energy which reaches the measuring cell is the key variable. This equipment is capable of detecting an interface between two liquids having a difference in specific gravity as small as 0.004.

A time lag between pickup and indication, sometimes called the "time constant," is inherent in all measuring systems and in our case is variable between 2 and 10 seconds. Thus, with a time-constant setting of 5, a perfect interface would be recorded as a sloped line 5 seconds long. A short time-constant record is desirable but it can be obtained only at the expense of signal-to-noise ratio. A long time-constant record is the most readable but the lag may be objectionable. Operating requirements will dictate the degree of compromise to be made.

An adjustable limit switch is used to actuate an alarm which alerts the operator to perform certain remote valve operations as required. Automatic valve operation, which may be desirable for some applications, is not

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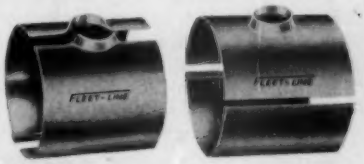

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a practical thing in this situation due to several operating conditions which change daily.

The installed cost of this type of system is over $3,000, compared with $300 to $900 for the dielectric-constant types which have been described. Therefore, it is obvious that one must have some very good reason for using a gamma-radiation system. Superior reliability and no internally mounted parts are factors which are strongly in its favor.

Safety

The danger of body exposure to excessive radiation is of paramount importance in the application of radioactive devices. In our application the source holder has lead-laminated brackets and a lead shield, as well as a specially designed rotary shutter. This shutter is opened only after the installation is complete and the unit is ready to operate. It is entirely satisfactory from the standpoint of safety.

At least one pipeline company has used the technique of injecting a radioactive tracer into the pipeline at one point and detecting the radioactive slug as it passes another point. The intent here would be to enable very accurate product cuts and minimize the amount of off-specification product between tenders. This interesting technique was reported extensively in various trade journals in 1953 (OGJ, July 6, 1953, p. 66), but for some reason, possibly the high cost, it has not enjoyed widespread use.

Recently a firm has come on the market with an interface-detection and product-separation system using specially designed liquid-filled rubber balls (OGJ, June 15, p. 86, and June 22, p. 116). These balls are slightly larger than the i.d. of the pipe, and when injected into a line at an interface, are intended to restrict the spread of the interface. When tagged with an appropriate radioactive tracer the balls can be detected and thus used to initiate an alarm or automatic-control function. This is a rather new development and we have had no operating experience with it.

Because of the imperative precautions required in handling radioactive material and the cost of the radioisotopes themselves as well as the detecting equipment, the use of techniques involving these materials are not particularly inexpensive. They certainly cannot be considered a cure-all for industrial interface-detection problems. Many of the interface-detection jobs for which one can use radioisotopes can be done more economically in other ways.

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Eighty percent of all mined underground storage for LPG has been constructed by Fenix & Scisson, Inc.

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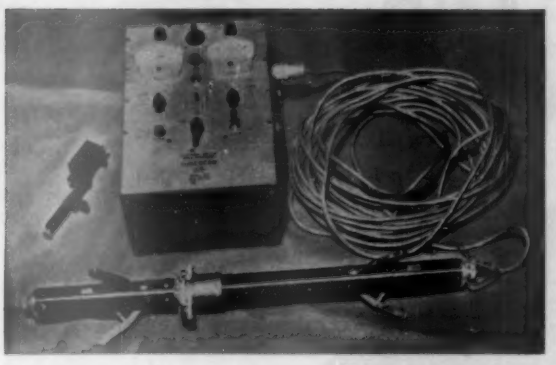

Scanner inspects tube interiors

. . . to determine their condition. As the Tubescan 105 probe is drawn through, it scans the inside of pipe or tubing and will detect defects and locate their position relative to the working end of the tube in feet. The probe advances in a spiral pattern at about 1/16 in. per revolution. When a defect is located, the machine is set on a special measuring circuit that measures defects between 0 and 0.3 in. deep to an accuracy of 0.01 in.

The machine is easy to operate and contains its own power, supplying 6 volts d.c. It sells for about $6,100. SOURCE: **Union Industrial Equipment Corp., Dept. OGJ, 40 Beech Street, Port Chester, N. Y.**

Three-way emergency valve

. . . just put on the market has been designed for remote pumping systems. It is a single-disk type that shuts off flow of fuel instantly in emergencies caused by fire or impact. The No. 9484 valve is designed to provide three-way emergency protection. On severe impact, the cadmium shear neck will sever, causing the valve to close.

The valve responds instantly to fire and extreme heat through a fusible link located up and away from the valve body. The link is held by a nonconductive wire to eliminate the possibility of the valve body acting as a coolant. The link will melt at about 160° F. permitting the valve to close.

Protection against slight impact is achieved through the use of an impact pin. SOURCE: **Buckeye Iron & Brass Works, Dept. OGJ, Dayton, Ohio.**

Dump valve for separators

. . . and other process vessels recently brought out has an elongated angle-style body designed for vessel adaptation that retards freezing action by absorbing heat from the gases at the top of the vessel.

The Type 125 antifreeze control valve can be operated by such instruments as intermitters, pressure controllers, and level controllers. Body is of cast steel with a pressure rating of 3,000 psi. (water, oil, or gas). It has 1-in. female NPT inlet and outlet connections and a 2-in. male NPT vessel coupling connection. SOURCE: **Fisher Governor Co., Dept. OGJ, Marshalltown, Iowa.**

●

Safety device for pneumatic equipment

. . . newly developed is designed to safeguard pneumatically operated equipment from all forms of moisture, oil, and contaminants. It looks particularly promising for locations where cooling water is unavailable, or where the ambient day-night temperatures vary a great deal. The Refrigifilter lowers the dew point of compressed air to about 35° F., condensing out over 90% of all moisture and oil vapor, the maker claims. At the same time, it removes the entrained liquids.

Rated at 100 s.c.f.m. at 100 psig. and 100° F., the unit combines a heat-exchanger, evaporator, refrigerating section, and a filter element all into a compact unit. SOURCE: **Hankison Corp., Dept. OGJ, College & Pike, Cannonsburg, Pa.**

Send this **Showcase Coupon**

to the Manufacturer of the item in which you are interested. See name, address, and equipment name and/or model, in bold-face type at end of description.

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Mission Rolling Dog teeth grip the hardest pipe available today with minimum stress concentration. New positive lock retains dogs in place. The standard rolling dogs and new solid inserts let these slips do the job of the heavyweights. You will find all the proved and popular Mission slip features: Segments are self-leveling as insurance against crimping the pipe. Top of slips is constructed to allow heavy elevator blows to be absorbed. Renewable hinge pins on these Lightweight Slips mean long life, less replacement. Flexible handles bend instead of break.

Mission Slips in 600,000 lbs. capacity slip test machine, with fourteen channel recording oscillograph measuring strains in slips and pipe.

These new slips—built like a bridge—are one more proof Mission knows drilling problems and knows how to overcome them. Available at your supply store.

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Power pack to increase safety

. . . in microwave and pipeline installations now available is designed to increase the margin of reliability and safety in control and switching operations. The Autocal power pack is designed to give peak d.c. power for microwave standby control and pipeline-network switching.

The package consists of lead-calcium-grid control batteries and a silicon charger. The charger keeps the battery fully charged automatically.

The charger can be mounted on a conventional 19-in. relay rack panel. Or it can be wall-mounted near control apparatus or above existing battery racks. It operates from a 115-volt power source. SOURCE: **C & D Batteries, Inc., Dept. OGJ, Washington & Cherry Streets, Conshohocken, Pa.**

•

New hardfaced taper mill

. . . comes in sizes from 4⅛ through 12¼ in. to mill cementing shoes, "orange peels," and float collars to full gage in a few minutes. The mills are dressed with Zitco, a fragmented tungsten carbide material that uses the cutting surfaces of hundreds of pieces of tungsten carbide. SOURCE: **A-Z International Tool Co., Dept. OGJ, 3815 Richmond Avenue, Houston 27.**

•

Gasoline dye in granular form

. . . has been evolved for refiners who color gasoline. The granular form is expected to eliminate dusting problems in storage and handling. The Calcogas Rocket Red dye is nondusting, noncaking, and very soluble, the maker says. Its granular form facilitates its use in automatic metering and mixing equipment.

It resists a change of physical state even at the high temperatures often found in refinery storage areas because of its noncaking properties, the maker says. SOURCE: **American Cyanamid Co., Dept. OGJ, 30 Rockefeller Plaza, New York.**

•

Teflon tape seals threaded joints

. . . on pipe and does not harden after it is applied, the maker says, permitting easy disassembly. To apply the new tape, called Tape-Seal, just wrap it once around the thread and tear it off. The tape is unaffected by temperatures from −250° to 500° F. and is completely inert.

Another advantage listed for the tape is that it does not "ride up" as pipes are joined. Instead it lubricates the joint and makes application easier

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Approximate on-the-job cost is between 1 and 2 cents a joint.

The tape comes in widths of ½, ¾, and 1 in. in rolls of 250, 500, and 1,000 in. SOURCE: **Friesland Plastics Co., Dept. OGJ, Friesland, Wis.**

●

Rotary four-wheel pipe cutter

. . . recently developed is designed for large steel and cast-iron pipe with diameters from 12 to 24 in. It consists of a separable circular frame joined at the midsections by hinged screws and adjusting nuts. An aluminum handle is placed successively over the eight lugs on the outside of the frame and used to tighten the cutter as cutting proceeds.

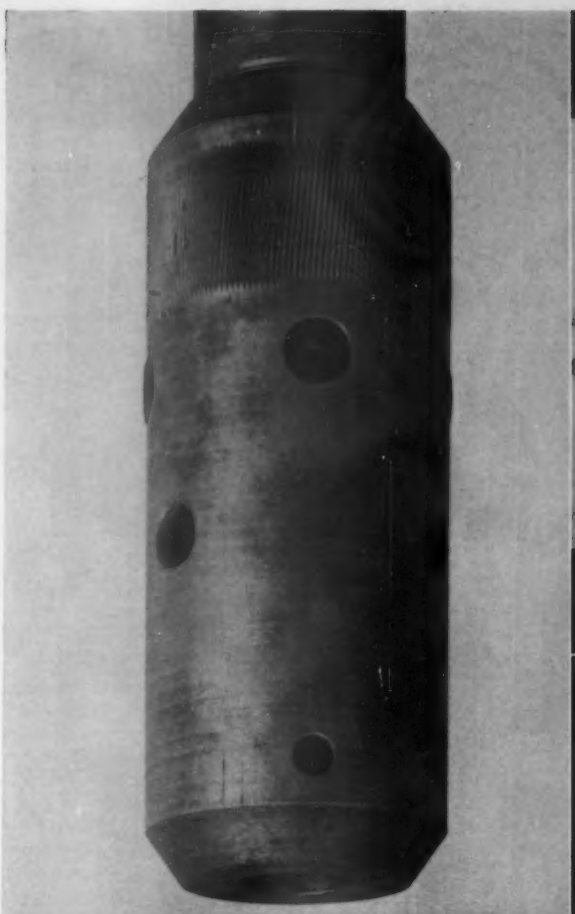
The 16-in. Reed rotary cutter weighs only 51 lb. complete. All units separate into three easily carried parts. Only 45 to 60° of handle swing are needed. Only a 6 to 8-in channel is needed under the pipe. SOURCE: **Reed Mfg. Co., Dept. OGJ, 1420 West Eighth Street, Erie, Pa.**

●

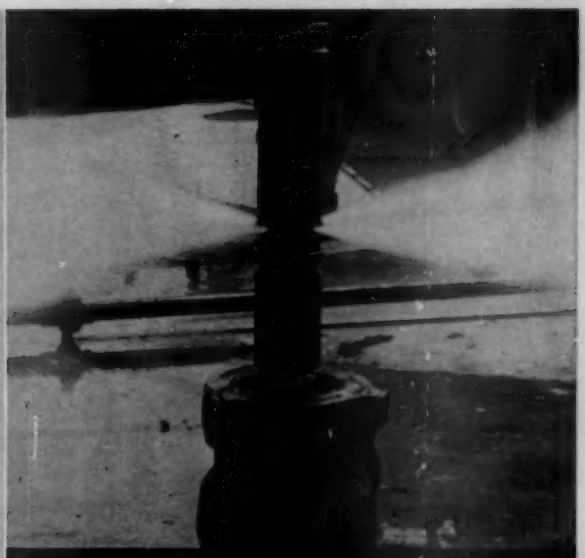
Air dryer removes moisture

. . . from air lines, providing clean air at the main line at a precisely regulated pressure. The maker says the Air Transformer will operate under the most difficult working conditions at full efficiency. It is automatic. No manual drainage is necessary.

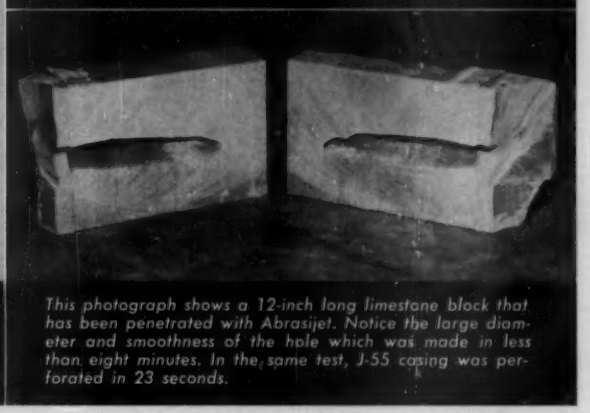
Main components are an automatic water separator and an air regulator. The separator is a baffle type. Air enters it through a filtering screen and is whirled downward over a bell-shaped baffle. When the air reaches the reservoir, its direction of flow is changed. This precipitates the moisture downward while the air expands



Here is the single-stage tool used in Abrasijet. The special-alloy jet-nozzles may be used in combinations of from two to seven jets. There is also a multi-stage tool with jets in three horizontal planes. Sliding sleeves permit the opening of the jets in each plane as needed.



Four open jets are shown in this demonstration. Abrasive-laden fluid, blasting through these nozzles, can enlarge open holes, remove insoluble deposits, cut slots in formations, and perforate casing without explosives.



This photograph shows a 12-inch long limestone block that has been penetrated with Abrasijet. Notice the large diameter and smoothness of the hole which was made in less than eight minutes. In the same test, J-55 casing was perforated in 23 seconds.

DOWELL ANNOUNCES ABRASIJET

—a new service developed to do things that "couldn't be done"

These photographs show the tool used in Abrasijet*, Dowell's *fast* new abrasive jetting service; and the way it works to solve oil and gas well problems that have been extremely difficult or impossible in the past.

Abrasive-laden water, oil or acid is pumped through jet nozzles against the pipe or formation. Sand, flint or steel pellets may be used as the abrasive.

Abrasijet is used to remove scale from formation faces or casing. It is used to perforate casing. It is also used to enlarge open holes, and to create slots to reduce formation breakdown pressures in acidizing or fracturing treatments.

When Abrasijet is used ahead of stimulation services, the casing can be perforated on the same set-up—without the expense of calling a special perforating unit. The stimulation treatment can usually proceed without the need of removing the tool from the well.

Since the action is primarily mechanical, Abrasijet removes deposits that resist acid. Because no explosives are used, there is no danger of shattering cement or splitting pipe.

Although Abrasijet was first used to clean up old water injection wells, operators are finding new uses for the service every day.

For detailed information on Abrasijet or prompt service, call the Dowell office nearest you. There are more than 165 service points in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma.

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SHOWCASE . . .

New Equipment

upward. SOURCE: **Spee-Flo Co., Dept. OGJ, 6614 Harrisburg Boulevard, Houston 11.**

•

Free-piston pump on market

. . . handles anything that flows, the maker claims. These fluids can include molten metal, concrete, plastics, acids, and semisolids. The pump has nine moving parts and moves fluid in stainless-steel chambers. Compressed air introduced into the cylinders operates it.

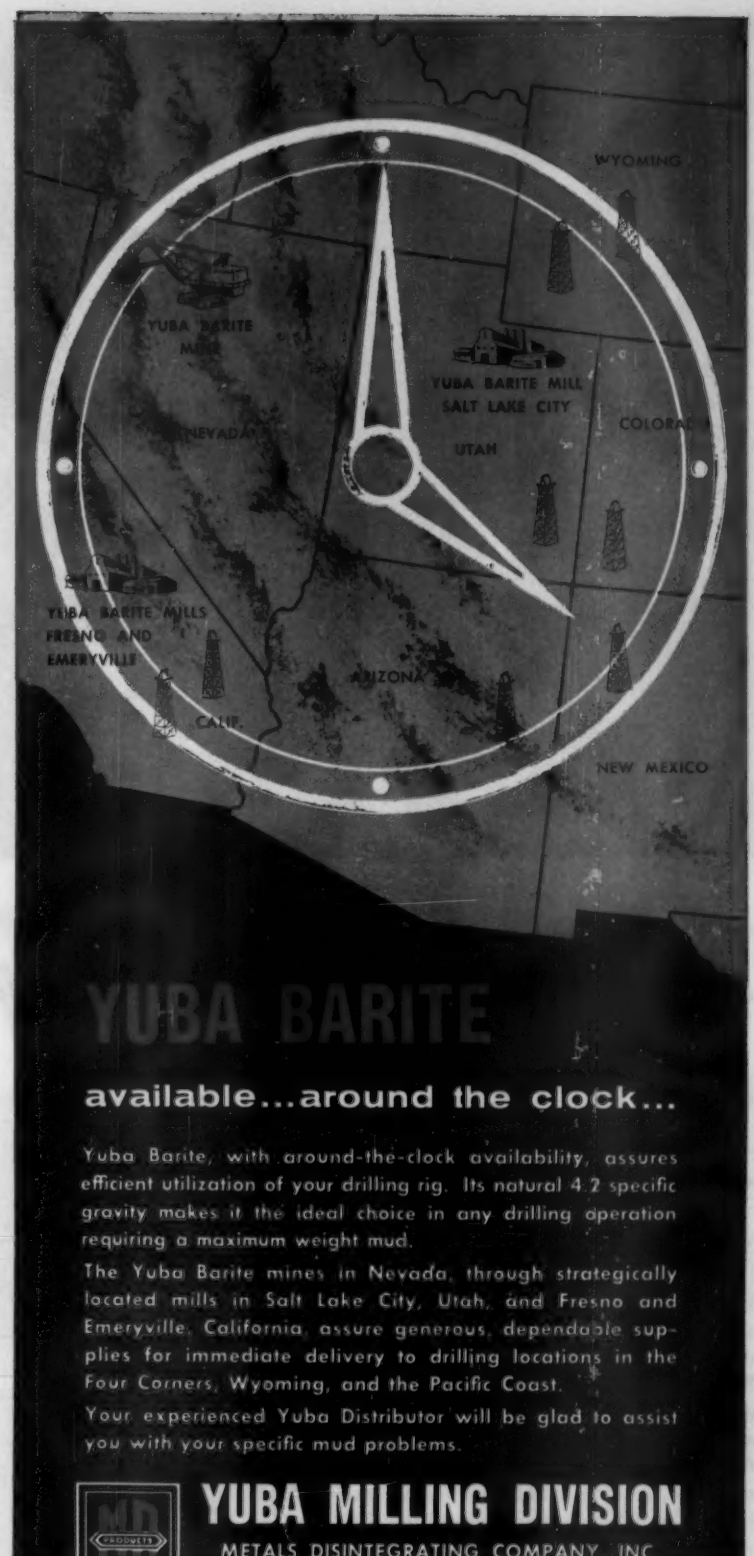
Each chamber contains a nylon free-floating piston and two nylon ball valves. One chamber can be stopped while the others continue to operate. This permits the pump to be operated indefinitely without shutdown. SOURCE: **Crossley Machine Co., Dept. OGJ, Trenton, N. J.**

•

Grooved-end pipe couplings, fittings

. . . available in a new line come in two series. Series 98-1 is for working pressures up to 500 psi., and Series 98-2 is for working pressures up to 1,000 psi. Both come with gaskets for either general service or for oil and gasoline. Bodies of the couplings are of malleable iron. The bolts are an oval-neck track type of heat-treated carbon steel.

To assemble the couplings, simply draw up the two bolts which extend through the coupling halves. The special gaskets grip the pipe ends, maintaining an even pressure around the pipe for a tight, permanent seal. The gaskets are resilient, enabling the piping to absorb pipeline stresses and movements safely. SOURCE: **Dresser Mfg. Div., one of the Dresser Industries, Dept. OGJ, Bradford, Pa.**



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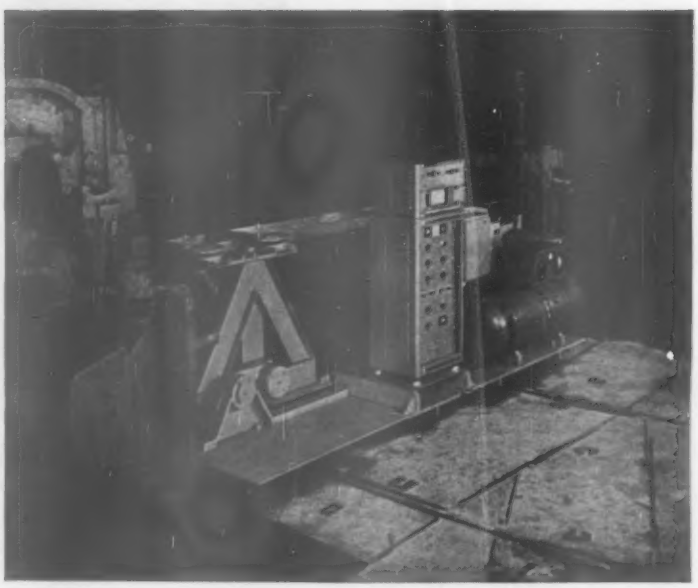

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Plan *now* for FARROWTEST®. Here is a nondestructive inspection method to supplement the many other quality safeguards provided by Republic. A unique eddy-current test providing the last word in quality control.

Exclusive with Republic Electric Resistance Weld Line Pipe, FARROWTEST depends upon the induction of electric currents in the pipe as it is passed through a series of detection coils. A defect in the pipe disrupts the flow pattern of these currents. Electronic detection devices send the message to the control panel to activate controls which reject the pipe automatically . . . independent of operator's observation or judgment.

Used by Republic with complete success in the production of tubular products for other critical uses, FARROWTEST is a *proved* performance safeguard. Experience has time and again proven its reliability in assuring top quality. In highly critical line pipe applications, the added assurance of FARROWTEST quality is particularly vital.

FARROWTEST has already taken its place in the production of Republic Electric Resistance Weld Line Pipe and is well along in test and verification trials. For complete information, write Republic Steel Corporation, Dept. OG-8127, 1441 Republic Bldg., Cleveland 1, Ohio.

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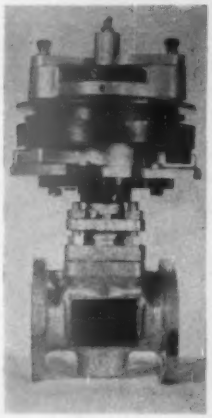


Operator-lubricator for plug valves

. . . now being produced is a self-contained automatic lubricator and mechanical operator that requires no pneumatic or electrical power. It is designed to not overlubricate valves but to allow additional lubrication if desired by the operator.

The Roto-Hammer operator and automatic lubricator provides a ground-lever control for remote operation of overhead plug valves, eliminating the need for expensive and hazardous platforms. Another advantage is that it can save on initial installation costs by enabling valves in overhead lines to be installed in straight runs, eliminating the need for routing piping to ground level or for providing a platform. It allows hand operation of overhead valves at ground level. Adequate lubrication is supplied before each valve operation. This feature can extend the life of valves and reduce down time for maintenance. Refilling the grease reservoir in the operator in overhead service is simpler than greasing the stem of a gate valve, the maker says. SOURCE: **Roto Hammer Co., Dept. OGJ, 2804 West Fortieth Street, Tulsa.**

●

Plastic welding rod

. . . is now available in three types which the maker says are particularly suited to field work in the petroleum industry. Called Kamlar, the rod is designed to be without voids and contains only virgin materials. The three available types are polyvinyl chloride, Types 1 and 2, polyethylene, Types 1, 2, and 3, and polypropylene. Sizes range from ⅛ to 3/16 in. The PVC rod is packaged in 2½, 5, and 25-lb. packages or tubes. The other two types are packaged in 3 and 6-lb. tubes. Rod length for all types is 57 in. Prices range from $2.45 to $3.82 a pound, depending upon the type and packaging. SOURCE: **Laramy Products Co., Dept. OGJ, 90 South Street, Hingham, Mass.**

●

Glass fiber tank is translucent

. . . making the liquid level always visible. The tank is made of a chemically inert polyester resin and reinforced with woven glass-fiber matting that can be custom-molded.

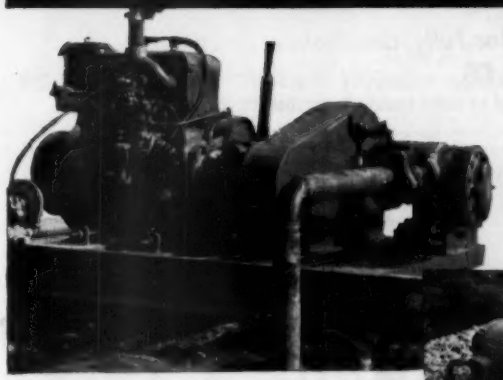
The tank can be obtained to desired specifications with capacities from 50 to 5,000 gal. and in any shape required, the maker says. The maker's standard tanks are immediately available in a variety of capacities and shapes, including horizontal cylindrical, oval, and hexagonal. SOURCE: **Hanson Equipment Co., Dept. OGJ, Beloit, Wis.**

●

Coffee pot for drilling rigs

. . . has been developed that is specially designed for use on either d.c. or a.c.-powered rigs. The unit is an electric-percolating type that makes

How They Rely on These ROPERS!



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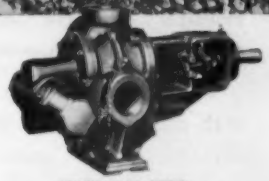
Regardless of the power supply used, ROPER PUMPS offer dependable service on continuous or intermittent pumping. These pumps give the advantage of design simplicity . . . two equal size, precision-mated gears run in axial hydraulic balance for positive displacement and assurance of smooth, non-pulsating flow in either direction of rotation. One of the outstanding features of the ROPER design is easy accessibility to the working parts. Neither piping nor mountings are disturbed whether for making a simple inspection or a major repair.

Specify ROPERS for close-in or remote installations. They will provide the *dependable pumping* you must have.



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SEMI-ENCLOSED — normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings in semi-enclosed protected housing, 40 degree C rise. Built for continuous duty. High Torque, low starting current. Extra insulating coating throughout.

TOTALLY ENCLOSED — Fan cooled, normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings, totally enclosed FAN cooled 55 degrees C rise, for continuous duty. High Torque — low starting current. Extra insulating coating throughout.

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Wherever positive, accurate control is required, DeZurik Control Valves provide the surest, most economical solution.

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For more details on the positive advantages of DeZurik Control Valves, see the DeZurik representative in your area, or write to Dept. CV for Bulletin 150.

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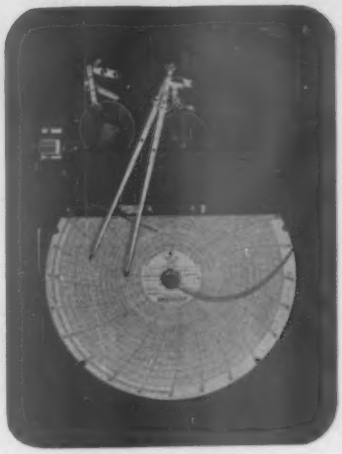

AMERICAN® INTEGRATING ORIFICE METERS

American Integrating Orifice Meters provide more accurate measurement by the continuous multiplication of the square root of the measured differential by the square root of the absolute line pressure.

Single, double and duplex-integrating models available in a wide range of manometer types and working pressures. Dust-proof, die-cast aluminum cases... Gasclok and electric instrument chart drives. Also supplied with American Telecounter for remote readings.

Ask for Bulletin 401 for complete details.

AMERICAN® METER COMPANY
INCORPORATED ESTABLISHED 1836
General Offices: Philadelphia 16, Pa.
Sales Offices in Principal Cities

10 cups and keeps it at drinking temperature. It is constructed to withstand voltage surges which may occur in the power system of an electric drilling rig. Price is about $12. SOURCE: **Rig-Pot Products Co., Dept. OGJ, 1622 West First Street, Elk City, Okla.**

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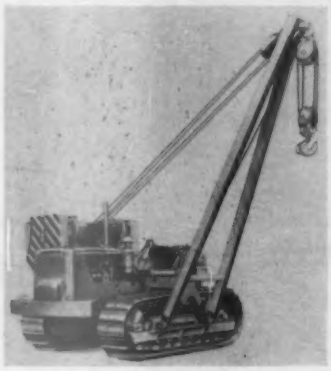


Pipelayer rollers need no greasing

. . . as they are permanently lubricated at the factory. Not only the track rollers but also the carrier rollers and idlers are permanently lubricated on this Model 572 Series D Pipelayer during factory assembly.

Other noteworthy features have also been included on the new machine designed to increase its working ability and to cut servicing time. For example, winch speeds have been increased to permit faster pipe handling. Lowering speed has been increased from 222 to 230 ft. a minute. A turbocharger has been added to the engine to increase engine flywheel horsepower to 140 from 128 hp. And, engine speed has been increased from 1,200 to 1,240 r.p.m. to match the increased horsepower to the torque converter. SOURCE: **Caterpillar Tractor Co., Dept. OGJ, Peoria, Ill.**

•

New compound to keep engines cool

. . . by preventing scale and sludge formation in the cooling system is on the market. When used in cooling systems containing scale, it removes the scale.

The resulting compounds remain stable over a wide range of temperature and pH. The maker reports that tests show the chemical is safe to use at normal operating temperature and even above the boiling point of water.

The compound is suited for use in standby engines to prevent scale and sludge formation as no heat is required for chemical reaction. The compound comes in 15 and 55 gal. drums and in cases of 24 pint cans. SOURCE: **Solvent Mfg. Co., Dept. OGJ, RFD 3, Box 353 G, Oklahoma City 7.**

•

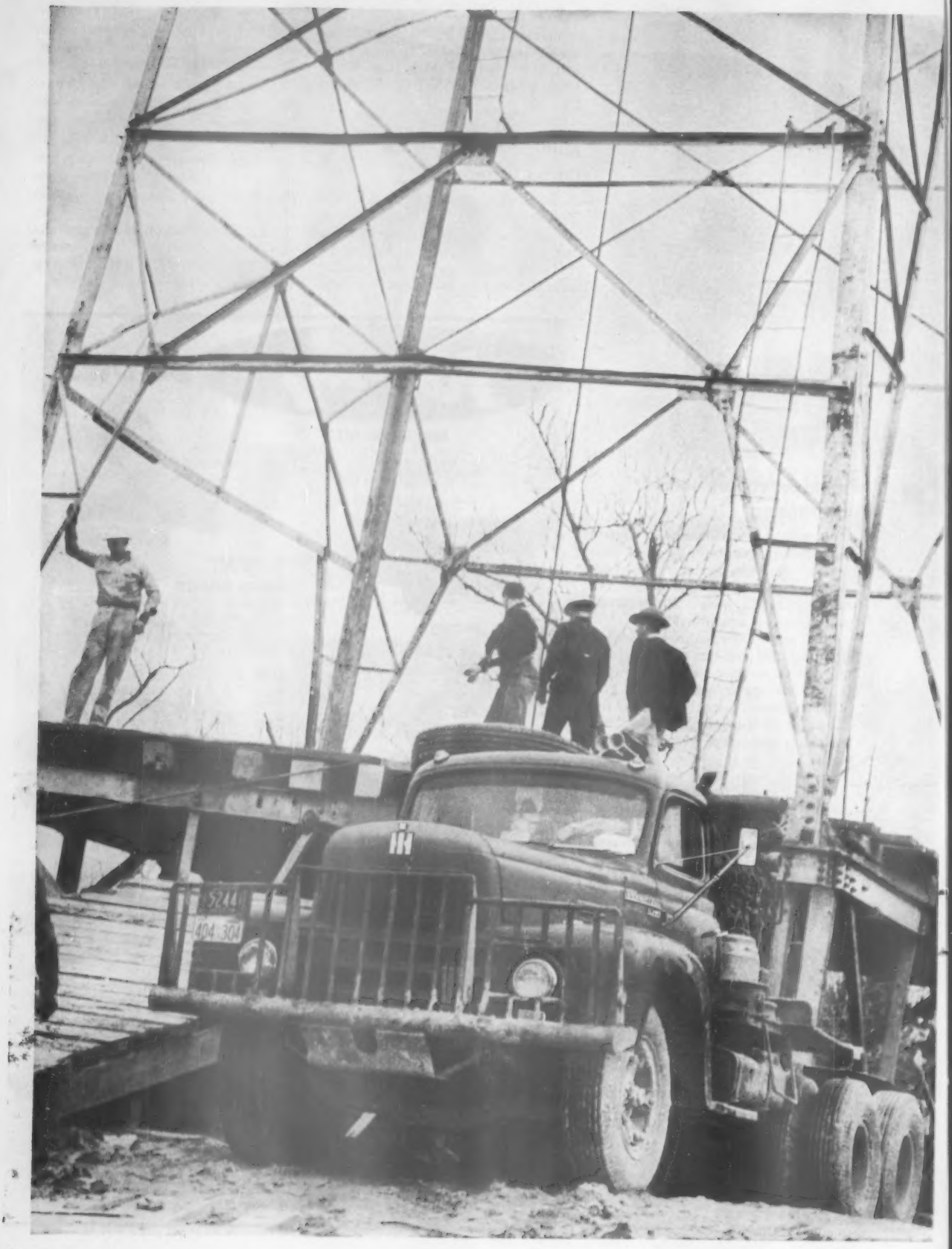
Multiport valve needs no lubrication

. . . as Teflon sleeves are used. The Tufline plug type of valve is made of stainless steel with either four or five ports.

The nonlubricating feature can reduce the need for maintenance as compared to lubricated type of valves. Too, the multiport design minimizes the number of valves required to achieve multiple flow patterns.

A wiping action of the sleeve keeps the plug free of adhering solids and liquids. Operating temperature ratings range from −150° to 400° F. Operating pressures can range from vacuum to 275 psi., depending upon the temperature. The valve is made in an ASA 150-lb. class in sizes of ½ through 2 in. with both flanged and screw ends. SOURCE: **Continental Mfg. Co., Dept. OGJ, 247 Park Avenue, New York 17.**

Koenig
BODIES
SERVICE BODIES
. . . for ½-, ¾-, and one-ton truck chassis. All-steel electrically welded into one unit . . . watertight compartments with double panel doors. Recessed paddle handles with cylinder locks keyed alike.
3-WAY
DUMP BODIES
Dump to the right, left and rear . . . the perfect dump body for windrowing, backfilling and precision dumping where space is limited. Adaptable to all standard truck chassis.
SIDE BOXES
For all pick-up trucks. Watertight compartments . . . double panel doors . . . recessed paddle handles with cylinder locks keyed alike. Eleven types, seven lengths available.
KING WINCHES
THERE'S A KING WINCH TO FIT YOUR NEEDS
Custom-made for practically all makes of trucks . . . complete, ready-to-install, ready-to-operate units with pulling capacities up to 19,000 lbs.
Write for free literature.
Koenig
INFORMATION IN REGARD TO YOUR SPECIFIC NEEDS ON REQUEST
IRON WORKS, Inc.
P. O. BOX 7726 • HOUSTON TEXAS

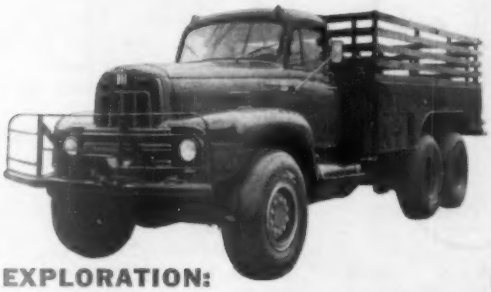


WITH INTERNATIONAL TRUCKS YOUR BIGGEST SAVING IS TIME!

INTERNATIONAL Trucks are built for dependability! Dependability that eliminates the "twice-up" costs of highly trained crews and specialized equipment standing idle as a result of unexpected downtime.

INTERNATIONAL oil-field-truck specialists are available to help specify the truck for your job on your job. They draw from the industry's widest selection of truck and oil field components, incorporate them into the world's widest selection of models. They tailor trucks for your special needs, to make sure you get the right truck when you want it!

See or call your INTERNATIONAL Dealer or INTERNATIONAL oil field representative today. Ask him about the specialized models and the world's largest exclusive truck parts and service network that can save you important time and money now!



EXPLORATION:

From powerful six-cylinder engine (up to 212 hp.) to all-wheel-drive and specially designed sand tires, this husky INTERNATIONAL model RF-190 (6x6) is built to carry men and equipment everywhere there's oil. Special rigging to meet special operating conditions in most foreign countries.

PRODUCTION:

The 54-in. bumper-to-back-of-cab dimension of this INTERNATIONAL model VCOF-405, plus rugged lightweight frame and suspension, allow you to mount servicing equipment in little overall length and remain legal. Ten ground points give greater flotation off the road, better weight distribution over it. Available with wide selection of gasoline, LPG or diesel engines.

TRANSPORTATION:

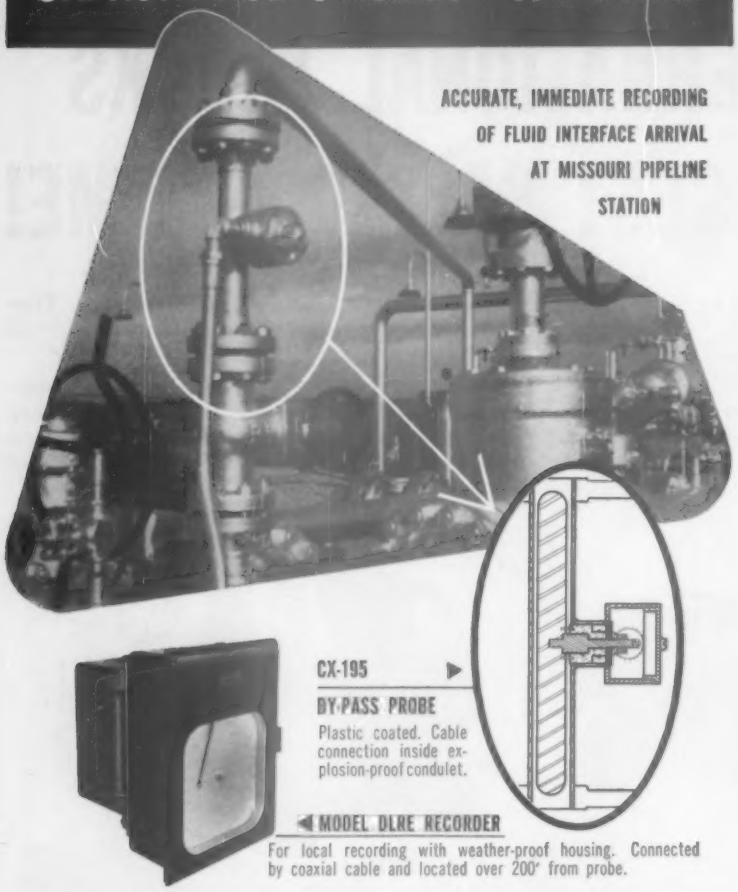
Ready to step in and do anything, this INTERNATIONAL model B-160 winch truck hauls pipe for gathering systems, draws up heavy welding equipment for job-site repairs, stays on the go all day long with all around versatility. Choose a power train that matches a six-cylinder or V-8 engine with standard, tandem or all-wheel-drive for smooth performance in any job, on any terrain.

INTERNATIONAL® TRUCKS WORLD'S MOST COMPLETE LINE

International Harvester Co., Chicago • Motor Trucks • Crawler Tractors • Construction Equipment • McCormick® Farm Equipment and Farmall® Tractors

BATCH INTERFACE DETECTION BY THE . . .

CAPACITANCE PRODUCT ANALYZER


ACCURATE, IMMEDIATE RECORDING
OF FLUID INTERFACE ARRIVAL
AT MISSOURI PIPELINE
STATION
CX-195
BY-PASS PROBE
Plastic coated. Cable connection inside explosion-proof condulet.
MODEL DLRE RECORDER
For local recording with weather-proof housing. Connected by coaxial cable and located over 200' from probe.

CPA measures and records interface, water content or component changes in the fluid stream by measuring dielectric differences of fluid passing through a probe. Recording is on 12" round chart.

SPECIFICATIONS

Range of Measurement: 4.3 MMFD minimum and 1100 MMFD maximum (equal to 1% min. and 35% max. for water in oil)
Accuracy: Within 0.5 of 1% of actual capacitance indicated (equal to ± 0.15 of 1% water in oil)
Sensitivity: Standard — 0.043 MMFD equivalent to 0.01 of 1% water contamination in oil
Power: 115 volt, 60 cy. A.C.
Recorder Motor: Electric or spring wound
Recording: Local — at or near point of measurement; Telemetering — over any pair of telegraph grade wires; Pneumatic — provides air signal at distant point
Housing: Explosion-proof or weather-proof
Optional Accessories: High-low alarm switches; 7-day or 30-day recording charts; Temperature compensation
Probes: 2", 3" and 4" flanged, grooved or threaded

INSTRUMENTS INCORPORATED TULSA

INSTRUMENTS, INC.

BOX 556 TULSA, OKLA.

PIONEERS IN LEVEL MEASUREMENT AND CONTROL INSTRUMENTATION

SHOWCASE . . .

New Literature

Instrument drive and timing unit

. . . which is air or gas-powered and completely self-contained is described in a new available bulletin. According to the literature, the instrument —called Gas Drive—will operate indefinitely and without attention.

It should be particularly applicable for remote location installations, such as offshore wells and gas-gathering systems, where it isn't always possible to manually wind a conventional chart drive.

Bulletin 1107 offers descriptions, applications, operation, photographs, and schematic drawings. SOURCE: **Meter & Valve Div., Rockwell Mfg. Co., Dept. OGJ, 400 North Lexington Avenue, Pittsburgh 8.**

Catalog details orifice plates

. . . along with sealing units and ring type of joint plate holders. The eight-page literature describes universal-size orifice plates for use in orifice fittings, as well as paddle-type orifice flange plates and plates for flow sections.

Catalog Section G also details three sealing units: dual, Teflon, and metallic seals. Complete information on design, sizes, ASA pressure ratings, and materials is given: SOURCE: **Daniel Orifice Fitting Co., Dept. OGJ, P. O. Box 19097, Houston 24.**

Mud-acid technical report

. . . describes the solution chemically, lists uses, summarizes methods of treating wells with the solution, provides laboratory data, and shows results obtained by using mud acid. The 16-page report contains tables, photos, case histories, and graphs which outline the effect of mud acid on productivity. SOURCE: **Dowell Division of The Dow Chemical Co., Dept. OGJ, P. O. Box 536, Tulsa.**

An 88-page hydrostatic-instrumentation

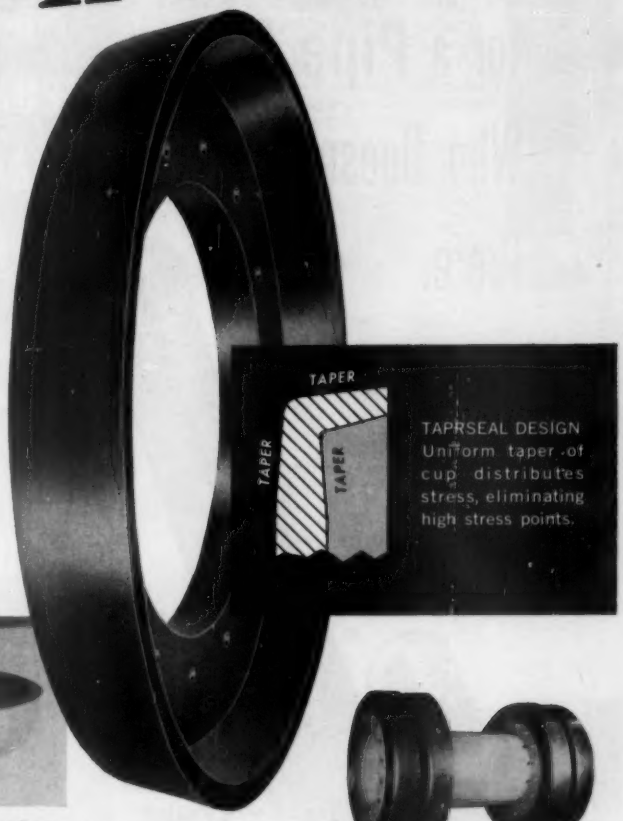
. . . handbook contains: (1) information on principles of hydrostatic measurement; (2) selection and installation of instruments; (3) design and construction of panel systems; and (4) engineering data and diagrams.

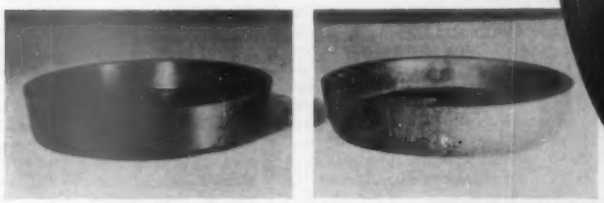
Instruments described in the pocket-size reference manual include liquid-level indicators; fuel-oil indicators; dial indicators; indicators for small tanks, hydraulic machinery

NEW WmSON TAPRSEAL®

SCRAPER CUP

OFFERS PROVEN RESISTANCE TO WEAR, TEAR AND SWELLING!





Actual photographs of TAPRSEAL cup before and after simulated pipeline test in ethyl gasoline for five days (500 miles)

Williamson testing equipment, the only repetitive COMPARATIVE cup tester in existence, has proven the TAPRSEAL to be WEAR RESISTANT . . . TEAR RESISTANT and SWELL RESISTANT. As the photographs show, there were no tears or breaks and only minimum wear after this torturous test.

Specify WmSon TAPRSEAL Scraper Cups . . . developed after years of research . . . proven after months of testing.

TAPRSEAL Scraper cups for all types of pipeline scrapers from 2" to 36".

PIONEERS OF PIPELINE EQUIPMENT

T.D. Williamson, Inc.

P. O. BOX 40 TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD

We're Still Looking for a Pipe Fitter Who Doesn't Prefer RIDGID®

"Of Course I said RIDGID . . . It's the only pipe wrench for my money. I've got work to do!"

At your Supply House

The Ridge Tool Company — Elyria, Ohio, U. S. A.

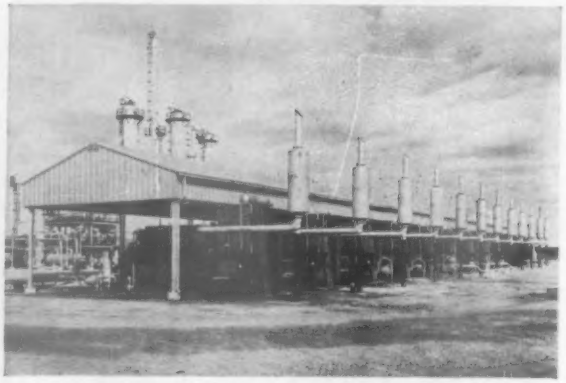
THREADED PIPE . . . It's Tight . . . It's Best . . . Costs Less!

BURGESS-MANNING

SNUBBER NEWS

Dedicated to the Elimination of Pulsation and Intake and Exhaust Noise

Snubbers Used to Quiet Compressor Engines



Burgess-Manning BES-12 Exhaust Snubbers, installed on engine compressors at Continental Oil's West Short Junction Plant, are eliminating excessive exhaust noise.

The West Short Junction Natural Gasoline Plant, owned by Continental Oil Co., in Cleveland County, Oklahoma, is one of the most efficient plants of its type in this country. Operated by only two men, it is noteworthy for both its low operation and maintenance cost and the many unusual operational features that contribute to its efficiency.

Among the distinguishing features of the plant is the absence of excessive exhaust noise from the 13-550 HP engine-compressors. Aware, through experience, of the high noise level of the exhaust from such a battery of compressors, Southwest Industries, Inc., who supplied the compressors, included a Burgess-Manning BES-12 Exhaust Silencer with each unit. The silencers are installed vertically at the end of the exhaust manifold so that the exhaust is discharged well above the roof. Considering the number and horsepower of these compressors, the West Short Junction plant is one of the quietest, as well as most efficient, plants in the Petroleum industry.

Cross section of a typical Burgess-Manning Snubber, similar to the type used at Continental's West Short Junction Natural Gasoline plant.

If you have an exhaust or intake noise problem, or a pulsation condition that causes dangerous vibration in a closed pipe line system, you will find it profitable to consult Burgess-Manning engineers for an effective solution.

BURGESS-MANNING COMPANY

Sound Engineering — *Industrial Silencer Division*

9217 Sovereign Row, Dallas 35, Texas
Libertyville, Illinois

reservoirs, and truck tanks; specific-gravity indicators; liquid-level controls; pneumatic manifold valves; safety cleanout valves; and miscellaneous products.

The handbook also includes 26 pages of information on tank-volume formulas, conversion tables, viscosity charts, hydrometer scales, and specific-gravity tables for various liquids. SOURCE: **Petrometer Corp., Dept. OGJ, 43-22 Tenth Street, Long Island City 1, N. Y.**

Roller-chain flexible couplings

. . . are illustrated and discussed in new Bulletin 597. It offers advantages of the couplings and carries information on how to select them properly. The literature includes a discussion on installation and maintenance procedures. SOURCE: **Chain Belt Co., Dept. OGJ, P. O. Box 2022, Milwaukee 1.**

Brushless synchronous generators

. . . in 40 to 300-kw. ratings are described in new Bulletin 51B9192 now obtainable. The four-page bulletin contains photographs, advantages, descriptions, characteristics, and specifications. SOURCE: **Allis-Chalmers Mfg. Co., Dept. OGJ, 864 South Seventieth Street, Milwaukee 1.**

Filter-media selection chart

. . . promises to guide you in the selection of proper engineering materials and filter media for given types of corrosive conditions. Prepared in booklet form, the chart lists filter media for varying concentrations of more than 125 corrosive agents. Primarily, the chart narrows down the choice of filter materials.

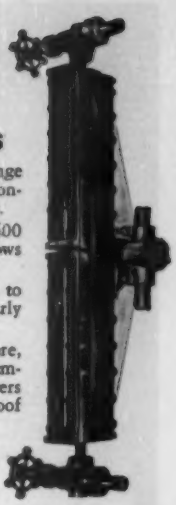
Sixteen-page Booklet PUR-66D also lists corrosive agents varying from acetic acid to zinc chloride, concentration percentages, temperatures, and filter media of metallic, plastic, or other-type design. SOURCE: **Purolator Products, Inc., Dept. OGJ, Rahway, N. J.**

Standards of identification symbols

. . . are contained in a new publication now obtainable. Entitled "Recommended Practice for Permanently Affixing Identification Symbols to Fabricated Piping," a copy is available free by filling out and mailing the enclosed inquiry card.

Identification symbols are recommended for general applications

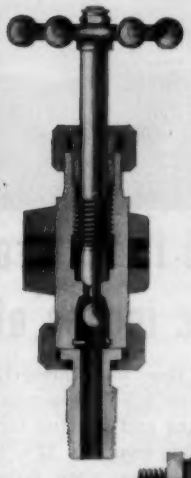
MEASURE
MIX
PUMP
EXHAUST
WASH
AERATE
AGITATE
COMPRESS
ATOMIZE
CIRCULATE
INJECT
EXTRACT



PENBERTHY
Direct Reading
LIQUID LEVEL GAGES

Designed with exclusive features for range of pressures, temperatures, corrosive conditions or other specific requirements.

- **REFLEX** — 3 pressure groups to 3600 psig. Lengths to 12 ft. Liquid shows black for positive accuracy.
- **TRANSPARENT** — 4 pressure groups to 10,000 psig. Lengths to 12 ft. Clearly shows color, density on media.
- **SPECIAL SERVICE** — High pressure, Frost-Proof, Heating Tube and Chamber, Welding Pad, Large Chambers and Inclined Gages, Explosion-Proof Illuminator.



PENBERTHY
GAGE VALVES

Exclusive "floating shank" saves on installation, eliminates strains common to forced installations.

- Threaded Valves for service to 6000 PSI
- Threaded Valves for service to 1500 PSI
- Stuffing Box Valves for service to 750 PSI
- Special Valves and Accessories.

PENBERTHY
EJECTORS

Hydraulic, air and steam operated Penberthy ejectors (jet pumps, eductors, exhausters and syphons) simplify handling of fluids, vapors, gases and "hot" materials. In a variety of standard and special designs and materials.

PENBERTHY
SUMP PUMPS

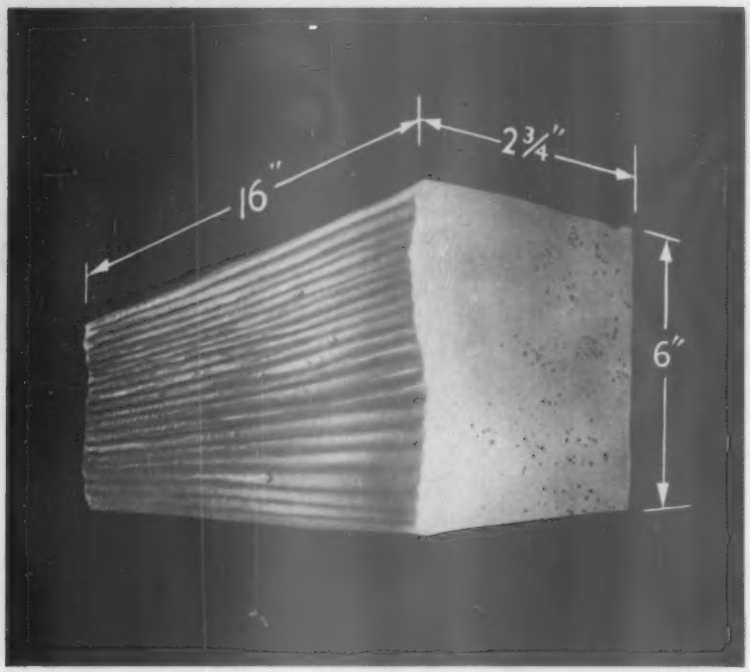
Automatic, electric, explosion-proof, submersible and standard types in 8 models, 20 sizes.

Your request for literature or specific engineering data, for any or all Penberthy products, will receive prompt, personal attention.

PENBERTHY MANUFACTURING COMPANY
Division of Buffalo-Eclipse Corporation
PROPHETSTOWN, ILLINOIS

There's Certain Satisfaction in **PRODUCTS BY** PENBERTHY

- EJECTORS
- INJECTORS
- CYCLING JET PUMPS
- LIQUID LEVEL GAGES
- GAGE VALVES
- SUMP PUMPS



How long did it take to gouge out this 64 cubic inches of steel?

Fourteen hours' time were formerly required to chip 64 cubic inches of metal from a 5-ton reaction-type turbine casting. Using the Arcair cutting and gouging torch the job was done in 1½ hours, saving this company 12½ hours of costly, hard work, not counting clean-up time formerly required — and completely eliminated with the Arcair process!

You can cut, gouge, bevel or groove **any** metal using the Arcair process — and get similar dramatic cost savings, with an investment of much less than $100.

HOW DOES ARCAIR WORK? The 1½-lb. torch utilizes Arcair COPPERCLAD electrodes, energized by current from a welding machine to melt the metal. Air from an 80-100 p.s.i. air line travels through the torch and out tiny holes in the head, pushing the metal ahead of the worked surface. Fifteen minutes instruction is all an operator needs.

WHAT'S YOUR PROBLEM? If you have a specific metal removal problem, or would like additional information, write us. Or, ask your welding supply distributor.

Arcair

ARCAIR CO., 479 S. Mt. Pleasant St.
Lancaster, Ohio
Send me more information on ARCAIR TORCHES and COPPERCLAD ELECTRODES.

(NAME) (TITLE)

(COMPANY)

(ADDRESS) (CITY) (STATE)

MY PROBLEM

H₂OIL
OIL TREATING SYSTEMS

"GAS GARD"

Your best insurance against loss of life or property wherever lease gas is used! Incoming gas is filtered **before** use. Three separate chambers within "GAS GARD" do it. As fluids build up in lower chamber, stainless steel float rises and shuts off gas until fluid is drained away manually. A size for any application.

IMMEDIATE DELIVERY

4" x 30" x 125 PSI

$75.70

F.O.B. TULSA

"GAGE-IT"

The Gauger's Delight

For determining oil-water, BS-water interface in stock tank. Fits any standard tape line. No batteries. Simple to operate. Nothing to wear out. Shipping weight approximately 2 lbs.

IMMEDIATE DELIVERY

$42.50
(Without Tape Line)

F.O.B. TULSA

Write for Literature

THE HOIL COMPANY

Oil Treating Systems
TULSA, OKLAHOMA
Or Thru Your
CONTINENTAL-EMSCO STORE

where different metal alloys are used in compliance with ASME or ASA codes. SOURCE: **Pipe Fabrication Institute, Dept. OGJ, One Gateway Center, Pittsburgh 22.**

Auto-fleet leasing publication

. . . analyzes advantages and disadvantages of auto-fleet leasing for company salesmen in cities and over the road. The available 24-page study includes charts which analyze costs involved in different fleet plans. It's based on records covering almost 30,000 individual autos. SOURCE: **Foundation for Management Research Dept. OGJ, 121 West Adams Street, Chicago 3.**

Conversion-factors wall chart

. . . gives about 400 conversions—such as liters to cubic centimeters and gallons to cubic feet—which are often difficult to find in reference manuals.

The 8¼ by 11½-in. black and yellow chart—which is free for the asking—furnishes such information as atmospheres to feet of water, pounds per square inch to inches of mercury, horsepower to British thermal units per minute, quarts (dry and liquid) to cubic inches, and microns to meters. SOURCE: **Precision Equipment Co., Dept. OGJ, 4409B Ravenswood Avenue, Chicago 40.**

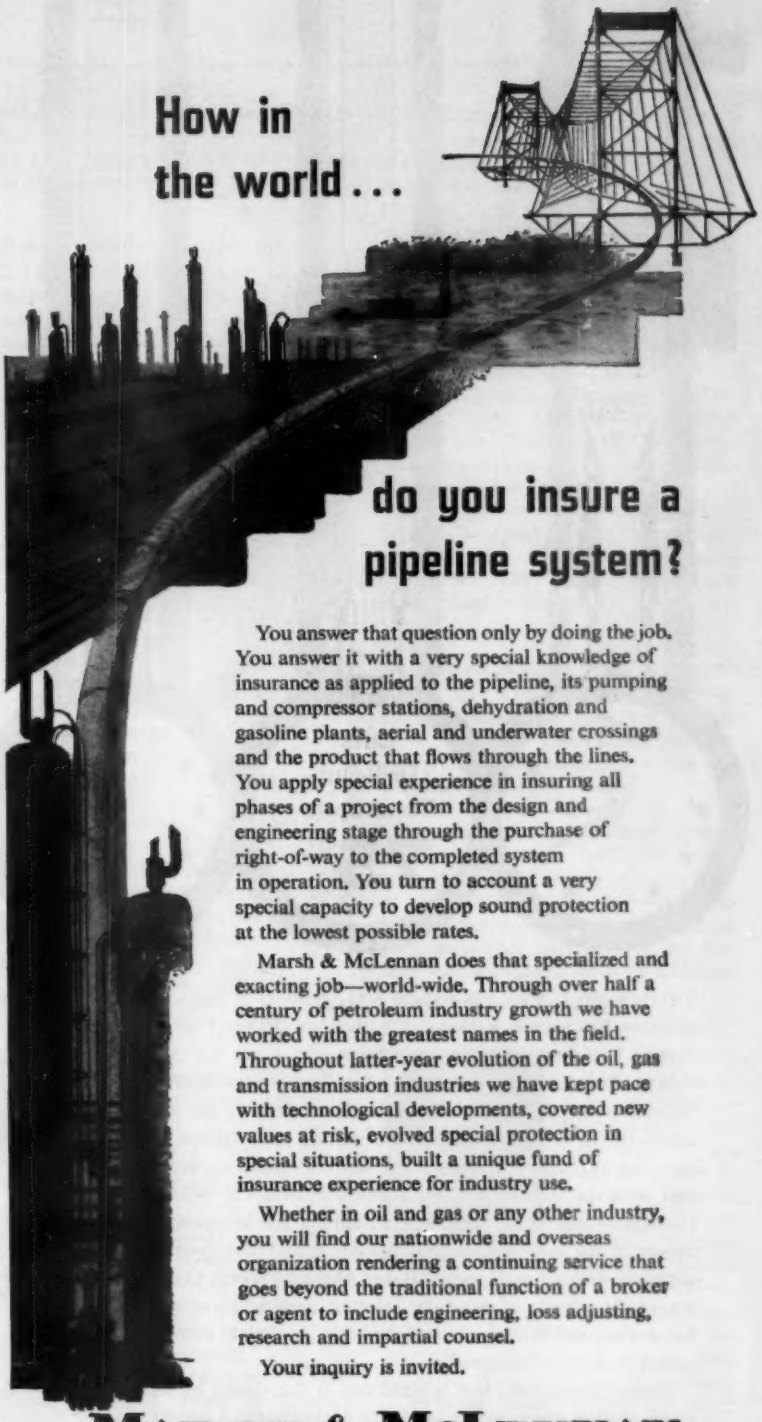
New standard heat-exchangers

. . . Bulletin B-20 features design and application information on six exchanger types. The 20-page literature contains tables of mechanical details, pictures, line drawings, thermal design data, and heat-exchanger calculations.

Also included is a table showing a typical range of values for size approximations and a graph giving the logarithmic mean-temperature difference. SOURCE: **Struthers Wells Corp., Dept. OGJ, Warren, Pa.**

Folder shows pump standardization

. . . which is achieved with the new Veriflow pump—a vertical single stage pump, covering the range of 1, 1½, 2, 3, and 4-in. pumps. The literature offers general information, descriptions, design and economy features, and sectional and outline drawings. SOURCE: **United Centrifugal Pumps, Dept. OGJ, 580 Second Street, Oakland, Calif.**



You answer that question only by doing the job. You answer it with a very special knowledge of insurance as applied to the pipeline, its pumping and compressor stations, dehydration and gasoline plants, aerial and underwater crossings and the product that flows through the lines. You apply special experience in insuring all phases of a project from the design and engineering stage through the purchase of right-of-way to the completed system in operation. You turn to account a very special capacity to develop sound protection at the lowest possible rates.

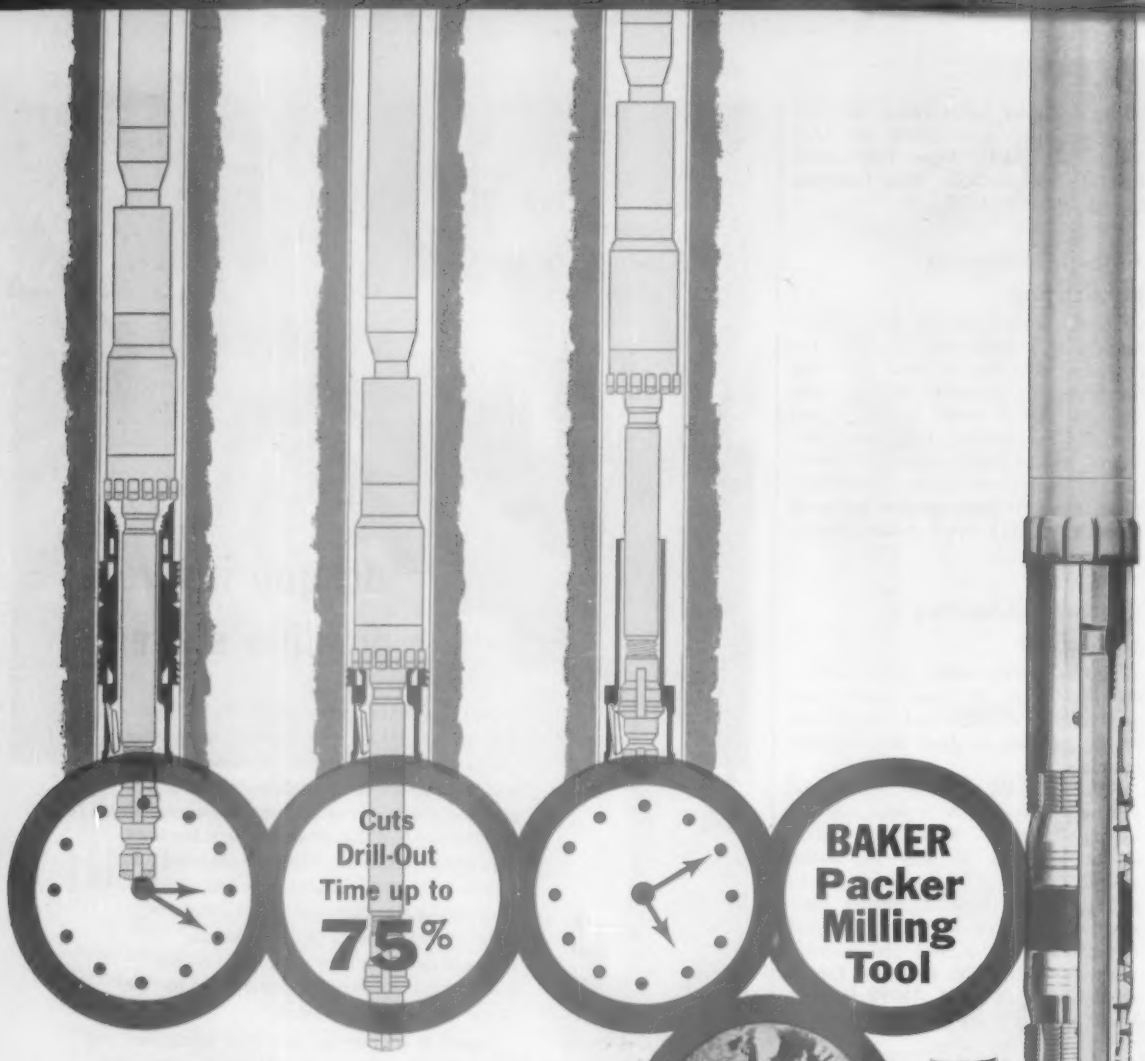
Marsh & McLennan does that specialized and exacting job—world-wide. Through over half a century of petroleum industry growth we have worked with the greatest names in the field. Throughout latter-year evolution of the oil, gas and transmission industries we have kept pace with technological developments, covered new values at risk, evolved special protection in special situations, built a unique fund of insurance experience for industry use.

Whether in oil and gas or any other industry, you will find our nationwide and overseas organization rendering a continuing service that goes beyond the traditional function of a broker or agent to include engineering, loss adjusting, research and impartial counsel.

Your inquiry is invited.

MARSH & McLENNAN
INCORPORATED
Insurance Brokers
CONSULTING ACTUARIES · AVERAGE ADJUSTERS

Chicago New York San Francisco Minneapolis Detroit Los Angeles Boston Pittsburgh Seattle St. Louis Indianapolis St. Paul Portland Buffalo Duluth Atlanta New Orleans Tulsa Milwaukee Phoenix Cleveland Norfolk Charleston Oakland Montreal Toronto Vancouver Calgary Havana Caracas London



THAT'S RIGHT . . . rock bits require 8 to 16 hours to drill-out drillable Production packers—but the new Baker Packer Milling Tool does the job in 2 to 4 hours.

Why does this new tool reduce the time so drastically? Because Baker engineers designed it to perform this one job efficiently. It is not an all-purpose milling tool. Hence, it does not mill up the entire packer, but *only* those elements that hold the packer in a set position against the casing.

Another important factor is the sustaining, self-sharpening action of the milling shoe and bottom sub. These cutting areas are dressed with special Baker Milling-Carbide Compound. Hundreds of carefully selected carbide chips are bonded in a matrix, and so distributed that an efficient milling action is always maintained.

During milling the tool is stabilized in the casing by its lower portion which rotates inside the packer body. A simple spring-loaded *catch sleeve* expands below the packer so that when the tool is retrieved, the remaining portion of the packer can be brought to the surface. This catch sleeve also provides a positive emergency release.

In addition to Baker production packers, the milling tool may be used for other drillable packers of similar design. It is available domestically on a low-cost rental basis, through your experienced Baker Serviceman—ask him for complete information or write for Catalog Supplement No. 353.

Set at 19,425 feet in 7-inch casing, this Retainer Production Packer was milled over in two hours and fifty minutes, and the cast-iron body and bottom of packer retrieved without damage to 4½-inch liner just below it.

PRODUCT NUMBER 747-C

BAKER OIL TOOLS, INC. • HOUSTON • LOS ANGELES • NEW YORK

Halliburton makes three changes

. . . in its field administration, according to R. G. Kelly, senior vice president.

J. L. McBride, who retired as Shreveport division manager, is succeeded by Travis Phillips, former division manager at New Orleans. Burton Aulick has been promoted from

Travis Phillips

Burton Aulick

assistant manager to manager at the New Orleans post.

McBride became associated with the late Erle P. Halliburton in 1921, 3 years before incorporation of the present Halliburton Oil Well Cementing Co. Since the death of the founder, McBride has been senior employe in length of service and has managed the Shreveport division since 1947.

Phillips joined Halliburton in 1940 and has worked in the Mid-Continent, Rocky Mountain, and Venezuelan oil areas. He has been manager at New Orleans since 1956.

Aulick, who began with the Duncan, Okla., firm 21 years ago, has worked in East Texas, the Gulf Coast, and offshore areas. Aulick had been assistant division manager at New Orleans since 1954.

Southern Pipe & Supply reports

. . . several organizational changes. A new supply store at Buffalo, Okla., is under the supervision of Jess Weaver, former field salesman at Cherokee, Okla. A new sales office at Pampa, Tex., is under the direction of Lyle Wells, who was transferred from Tulsa.

Another transfer from Tulsa—Bill Hines—takes over the company's Wichita office, and Leo Mullens, former store manager at Pawhuska, will now manage Southern Pipe's Houston office.

Other changes include: Charles Brown, promoted to Pawhuska store manager replacing Mullens; R. D. Hays, promoted to field salesman; Gene Geist, employed as a field salesman; and Andy May, employed to work in the Pawhuska store.

In addition to his duties as Tulsa office manager, Jack Bluestein has been named administrative manager, in which capacity he will have charge of the operations of all field stores.

Brown Fintube Co. sets up

. . . affiliated plants in four countries. Brown licensees are located in Canada, England, France, and Germany, and have on their staffs designers, engineers, and fabricators familiar with the application of heat-transfer products.

R. E. Miller is made manager

. . . of the Chicago district office of Rockwell Mfg. Co.'s Meter & Valve Division, according to P. C. Kreuch, vice president. Miller, who has been manager of industrial meter sales, Petroleum & Industrial Division since last year, joined Rockwell 12 years ago in the market-research department.

R. E. Miller

In 1950, he was appointed staff assistant, accounting department, and since then has been assistant sales manager of Ohlen-Bishop; sales manager of Rockwell Tools, Inc.; product sales manager, Delta Power Tool Division; senior sales engineer, New York district office, Meter & Valve Division; and supervisor of gas-products sales.

Before assuming his most recent position, Miller was assistant product manager, lubricant sales, Meter & Valve Division.

William B. (Ben) Adair is named

. . . assistant vice president by Macco Oil Tool Co., in which post he will serve as director of engineering and product sales coordinator. He will locate in Houston.

Adair worked with Macco from 1953 to 1956 as sales engineer, chief engineer, and distributor in Houma, La. For the past 3 years he has been working with Parkersburg Rig & Reel Co. as division product application engineer and division sales engineer. Prior to his employment with Macco, Adair was a petroleum engineer with Associated Engineers of Houston.

L. H. Busby is named manager

. . . of the southern region of Security Engineering Division, one of the Dresser industries, reports Security's Sales Vice President, Claude L. Griffin. Busby, former regional sales representative for the Dallas concern, now will supervise sales activities throughout South and East Texas, Louisiana, Southern Arkansas, Mississippi, Alabama, and Florida.

L. H. Busby

Busby earlier represented American Iron & Machine Works in engineering and sales capacities in the same areas. He will locate at Security's main plant in Dallas.

Jack Kohl is appointed manager

. . . of the western sales region of Black, Sivalls & Bryson, Inc.'s Controls Division, reports Charles R. Bootz, division manager. Kohl will headquarter in Los Angeles.

Kohl formerly served in Philadelphia where he had been district sales manager since 1957. He started with BS&B in 1953 as a sales engineer in the Chicago office. Previous to joining the company, he worked as an engineer for Sherwin-Williams Co. and Visking Corp., both in Chicago.

Cooper-Bessemer Corp. forms

F. M. Devin

. . . a new sales district by consolidating the Western Pennsylvania and Ohio areas, announces Grant C. Woodard, general sales manager of the Mount Vernon, Ohio firm. Headed by F. M. Devin, vice president and district manager, the territory will be known as the east central district and will be composed of three individual territories.

Working under Devin are three branch managers: R. L. Reynolds, Grove City, Pa.; J. R. Craine, Mount Vernon; and J. M. Brannaman, Pittsburgh.

J&L reassigns O'Brien, Rankin

. . . to new positions, announces W. L. Wolfe, vice president, sales, of Jones & Laughlin Supply Division. B. G. O'Brien, salesman at Salem, Ill., has

been assigned to Greensburg, Ky., and J. H. Rankin, salesman at Kermit, Tex., goes to Hobbs, N. M.

O'Brien began his career with Jones & Laughlin in 1943 as a storeman at Perry, Okla. He was promoted to store manager at Reed City, Mich. in 1945, and later transferred in the same capacity to Mt. Pleasant, Mich. O'Brien served as salesman at Mt. Pleasant and was later transferred to Salem.

Rankin entered J&L's sales-training program in 1957 and completed training in January 1959. He then became a salesman at Kermit.

R. G. LeTourneau, Inc. offers

. . . its Steel Division products to the open market, and announces that James R. Anderson has been employed to assist in handling the needs of steel sales customers. Anderson recently completed 6 years with Earl M. Jorgensen Steel Co., Dallas.

The Steel Division, located at the headquarters plant in Longview, Tex., produces a variety of electric-furnace, laboratory-controlled plate. During previous years, output of the 300-ton-per-day mill has gone to supply LeTourneau manufacturing facilities at Longview and Vicksburg, Miss., plus a limited number of outside accounts.

F. H. Foglesong is appointed

. . . to the newly created post of manager of alloy sales for Babcock & Wilcox Co.'s Tubular Products Division, announces Leon B. Wohlgemuth, the division's general sales manager. Foglesong will headquarter at the division's general offices in Beaver Falls, Pa.

Succeeding Foglesong as manager of the division's Detroit district sales

F. H. Foglesong

A. D. Zar

office is A. D. Zar, who had been sales representative in the Milwaukee district office.

Foglesong joined Babcock & Wilcox in 1947 as a Detroit district salesman and was appointed district manager 2 years later.

Zar began his career with Globe Steel Tube Co. in Milwaukee in 1936, and served in various capacities in production and sales departments. After Babcock & Wilcox purchased Globe Steel 3 years ago, Zar was made Milwaukee district sales representative.

Representatives are named

. . . for RCA mobile communications equipment in five areas, announces R. C. Dubois, Jr., sales manager of the communications products department, Radio Corp. of America.

Newly appointed manufacturer's representatives are: J. F. Ottmar Co., Spokane; Mobile Radio Service & Communications Corp., Shreveport; Miami Mobile, Inc., Miami; Rocky Mountain Communications Co., Inc., Denver; and Modern Electronics Laboratory Corp., Syracuse.

D. R. Ruffin joins Rayonier, Inc.

. . . as special field representative to the domestic oil industry, reports Michael A. Brown, general sales manager of the chemical cellulose and silvichemical manufacturer.

In this newly created position, Ruffin will concentrate on sales and service aspects of the company's line of

skid-mounted
AUTOMATIC CRUDE OIL METERING ASSEMBLY
. . . with proportional sampler

Unit automatically shuts down after allowable has been flowed, with volume corrected to 60°F and registered on counter and/or ticket.

MECO sampler stores sample at line pressure.

Air and non-condensible gases are automatically separated from liquid and vented. Metering of gases is prevented.

Unit includes line-size strainer • SMITH line-size deaerator • float-operated pilot and safety shut-down valve • MECO proportional sampler • A. O. Smith positive displacement liquid meter • SMITH set stop valve.

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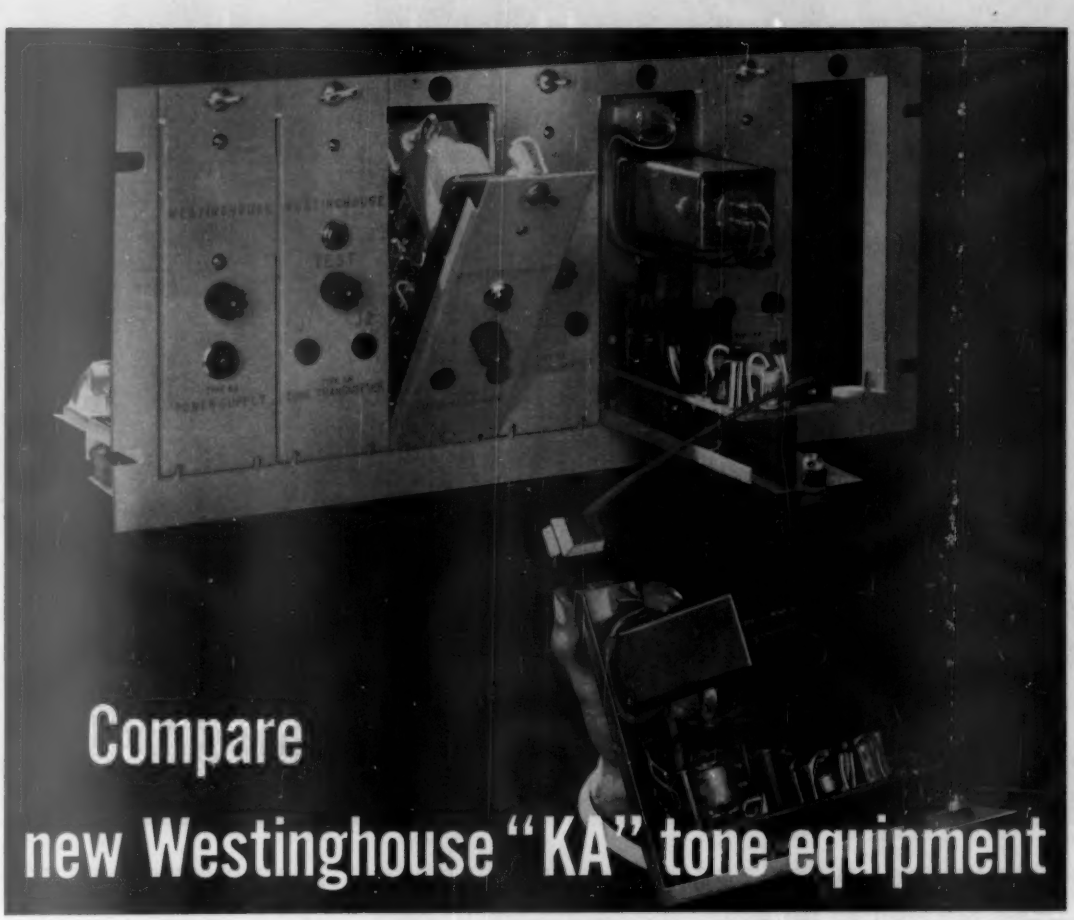

at $322 per channel, complete*

You can't afford not to compare value received in the new line of Westinghouse Type KA audio tone equipment . . . the optimum design considering performance and space factors at an average cost of only $322 per channel, for *all* equipment.

Using less than 1.6 rack spaces per channel, KA tone equipment will handle high-speed teletype and high-speed data transmission. For example, up to 100 words per minute can be transmitted with 170-cycle channel spacing. Up to 18 channels can be provided over a single voice frequency circuit using wire lines, microwave radio or power line carrier.

Fully transistorized KA tone equipment is available for on-off control, impulse-type or frequency-type telemetering, supervisory or load control, teletype and other telegraphic-type functions—for remote indication, measurement, control or data transmission. Modular, self-supporting "flip-out" construction requires no rear access. This, plus elimination of tubes and availability of normal, routine check test points on fronts of panels, simplifies and reduces maintenance to an absolute minimum.

For full information on Type KA audio tone equipment, or other Communication and Control Products, contact your Westinghouse representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

J-60985

*Actual per channel cost varies according to the number of channels per common frame and power supply. The $322 figure is an average per channel price. Actual prices vary from $343 to $300 per channel for 6 to 25 channels respectively.

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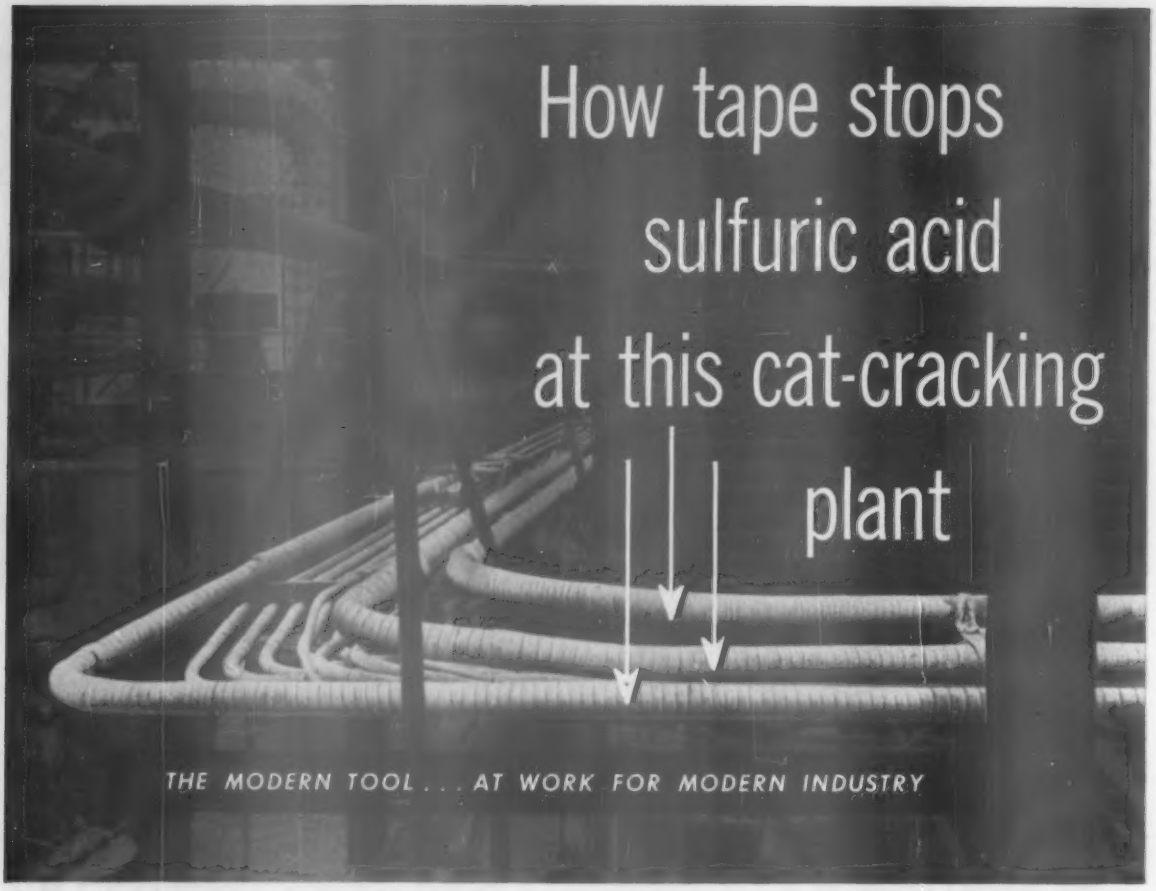

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Look in on one of the world's largest fluid catalytic cracking units. A maze of conduit and pipe exposed to an extremely corrosive sulfuric acid atmosphere.

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Cleveland, Ohio: The Harco Corp.
Denver, Colorado: Patterson Supply
Des Moines, Iowa: Donald Corporation
Fort Worth, Texas: Plastic Engineering & Sales Corp.
Harvey, La.: Allen Cathodic Protection Company, Inc.
Houston, Texas: Cathodic Protection Service
Kansas City, Missouri: Industrial Coatings Engineering Co.
Long Beach, Calif.: Barnes & Delaney
Memphis, Tenn.: General Pipe & Supply Co.
Minneapolis, Minn.: Simcoe Equipment Co.
Philadelphia, Pa.: Harold N. Davis Co.
Plainfield, New Jersey: Stuart Steel Protection Corp.
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Seattle, Washington: Farwest Corrosion Control Corp.
Seattle, Washington: Pacific Water Works Supply Co.

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THE KENDALL COMPANY
Polyken Sales Division

Rayflo oil-well drilling-mud dispersants. Prior to his employment with Rayonier, Ruffin was with Sunray Mid-Continent Oil Co., as a drilling-mud engineer.

Marshall L. Stirling is named

. . . special representative to the oil, gas, and chemical industries for Butler Mfg. Co.'s Buildings Division. He will assist and supplement field sales efforts with companies in these fields, reporting directly to Butler's main office in Kansas City.

A 2-year company employe, Stirling formerly was sales manager of the company's Union Tank Division in Houston. Previously he spent several years in the natural-gas department of Magnolia Petroleum Co., and was with Dowell Division of The Dow Chemical Co. for 16 years. He was Dowell's general sales manager.

Mark C. Parker is promoted

M. C. Parker

. . . to service manager of Brewster Co., announces John L. Morgan, director and sales manager of the Shreveport firm. Rising from a shop machinist and assembler in the Brewster plant, Parker served as a field representative for 6 years until 1955, when he was appointed assistant service manager.

Field service representative posts were given to R. T. Hester, Houston; Billy D. White, Odessa, Tex.; and Gerald C. Wiley, Shreveport.

Meanwhile, Lawrence Hare was transferred from Shreveport to Oklahoma City, and J. D. Harrison was moved from Casper, Wyo., to the company's parts and service branch office in New Iberia, La.

Daniel Orifice Fitting Co. adds

. . . Ken Kendall to the Los Angeles sales force. Prior to joining Daniel, Kendall was a sales engineer with Rockwell Mfg. Co. for 5 years.

Welex announces duty changes

. . . for seven executives as a result of a company expansion program. In Fort Worth, former Sales Vice President J. B. Vaughan has been named vice president for cased-hole services.

In Houston, G. T. Armstrong, vice president and former manager of research and engineering, was named vice president for open-hole services and appointed to Welex, Inc.'s executive committee. His office will remain in Houston. Former Chief Research Engineer O. R. Smith assumes the job of manager of research and engineering, and the Houston interpretation section, under Chief Evaluation Engineer Terry Walker, is now a part of the sales department.

Research and Engineering Vice President W. J. Green will be assisted in handling patents and other legal matters by H. K. McArthur, research and engineering vice president.

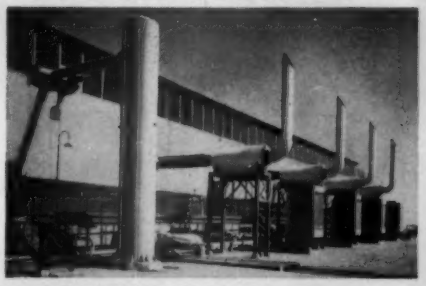
H. B. Hurley, assistant to the president, has been named to head the Gulf Coast sales organization with headquarters in Houston.

Wayne Tilton is appointed

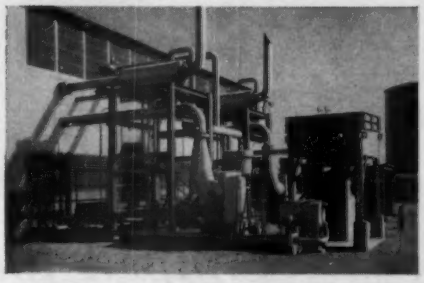
. . . a transportation consultant to the petroleum industry by KLM Royal Dutch Airlines, according to Dirk J. Koeleman, vice president and general manager for the United States. Tilton will locate in New York City.

Prior to joining KLM, Tilton was with Robert H. Ray Co., Houston. Since 1952, he has been stationed in Saudi Arabia, Tripoli, and Libya.

COMPRESSORS AND



GENERATORS ARE



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Success at first Yukon strike proves . . .

Logistics pay off

A SAGA of modern drilling was climaxed when Western Minerals, Ltd., made a gas strike in excess of 8 M.M.c.f.d. at its 1 Chance well in an unsurveyed area of Canada's Yukon Territory.

The location is just south of the Arctic Circle and is within 200 miles of the Arctic Ocean. It is about 2,200 miles north of Calgary, Alta., center of much Canadian drilling. For comparison, Calgary is about 2,200 miles north of Dallas.

The temperature at the location sometimes reaches −60° F. Mid-winter nights are 24 hr. long. Before the job could begin, the rig with its equipment and supplies, totaling 2,500 tons, had to be hauled hundreds of miles across snow and ice on tractor-drawn sleighs.

Plans to drill in the area were based on geological work that began in 1953. Drilling was by Parker Drilling Co. of Canada, Ltd., using a Type 55 rig manufactured by National Supply Co.

Equipment Assembled in 1956

Purchased for the project, the rig has special moisture-removal equipment to prevent the air lines from freezing. It was assembled at Edmonton and drilled a shakedown well at Bruderheim, Alta., in September and October 1956. In addition to the Type 55 draw works, with a sand reel and dynamic brake, the rig includes a two-section National drive group with two General Motors engines, equipped with torque converters. Two National C-250 slush pumps are each powered

STAGING AREA at Flat Creek, 30 miles south of Dawson City.

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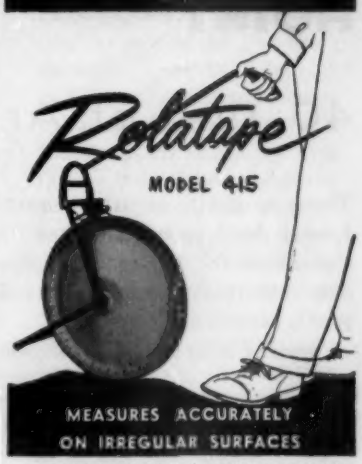

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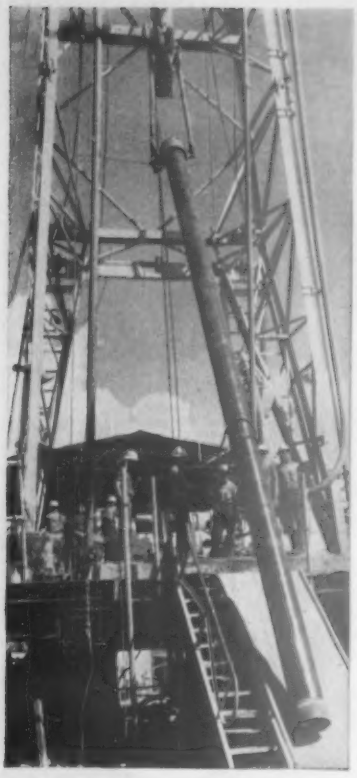

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Armco Casing is quickly available. Contact the nearest National Tank Company stocking point listed below. For complete details, write us for the catalog "Armco Casing for Oil and Gas Wells." Armco Drainage & Metal Products, Inc., 5629 Curtis Street, Middletown, Ohio, or 201 KOME Building, Tulsa, Oklahoma.

National Tank Company stocking points for Armco Casing: Casper, Wyoming; Clay City, Illinois; El Dorado, Kansas; Farmington, New Mexico; Great Bend, Kansas; Harvey, Louisiana; Hobbs, New Mexico; Houston, Texas; Lake Charles, La.; Liberal, Kansas; New Harmony, Indiana; New Iberia, La.; Odessa, Texas; Oklahoma City, Okla.; Pampa, Texas; Perryton, Texas; Seminole, Okla.; Shreveport, La.; Sidney, Nebraska; Snyder, Texas; Williston, North Dakota.

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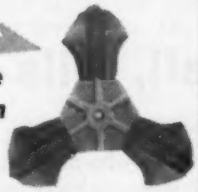
Here Are "Dead Men THAT HOLD!"



Quicker! Stronger! Use Grip-Tite Expanding Anchors for "Dead Men That Hold!" Use for portable drilling mast, well servicing mast, pulling truck, floor blocks, derrick guy wires.

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by General Motors diesel engines.

The drill string is supported on a 133-ft. Lee C. Moore mast, using a National hook-block, Type "E" swivel, and an SHS 20½-in. rotary. Blowout equipment consists of a Hydril GK 12-900 and a 12-in. Series 900 Double Shaffer, with an 80-gal. Hydril automatic accumulator.

After the shakedown well was completed, the rig and equipment were trucked from Edmonton to Flat Creek, about 30 miles south of Dawson City, famed boom town of the Klondike gold rush.

Rig Hauled by Cat Trains

Two cat trains were used, operating a shuttle service that carried the equipment and supplies to the original well site, 1 Eagle Plain. Started late in December 1956, these trips continued until the middle of March 1957. Each train consisted of six or seven tracked vehicles, each pulling three or four sleighs, with a total load of 60 tons. Two complete crews were assigned to each train, permitting day and night travel. Trail cabooses for cooking and sleeping, and a workshop caboose, were part of each train.

Although stops en route were made only to refuel and to eat, each 600-mile round trip took about 20 days. Some of the mountains passed are 7,000 to 8,000 ft. high. Through December, January, and February, temperatures in the area are normally −40° to −50° F., and may drop to 60° below. Snow is piled up three to four ft. deep until the spring breakup around May 15. At some points the trains crossed frozen streams that would be impassable after the ice melted. For this reason, sufficient supplies were taken to last through the summer.

This location was the farthest north that a rig has operated in Canada.

When the original hole proved dry, the rig and equipment were moved 50 miles to a new location in February 1959. The well was spudded in early June, about the time of the spring breakup. The gas strike, at about 4,250 ft., was reported August 17. The well also contains light-gravity oil.

Radio communication is maintained with Dawson City and other points. New crews are flown in every 3 months.

Success of the 1 Chance well is expected to influence other companies to begin drilling in the Yukon and Northwest Territories, where reservations already have been placed covering over 80 million acres. An additional 80 million acres in Arctic islands off the northern coast of Canada are covered by reservations.

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When E. L. Drake completed America's first oil well 100 years ago in Titusville, Pennsylvania, more than an industry was born —*an epoch was launched.* Since that eventful day, petroleum has revolutionized agriculture, industry and transportation, created great national wealth, and lifted burdens from men's backs the world over.

Yet, significant as it was, the Titusville well should not obscure an earlier event in New Haven, Connecticut. There, *men with venture capital and the courage to risk it,* first envisioned the commercial possibilities of Pennsylvania "rock oil". And, in 1858 they chartered the Seneca Oil Company, which sent Drake to prospect on its Titusville land.

Like the explorers and drillers, *the true adventurers of oil are those who venture their money.* It is they who have sustained the oil industry, the chief source of the world's energy.

In this Centennial year, Sinclair salutes those early venturers, the first stockholders of Seneca Oil Company. They were the predecessors of almost four million men and women who today own most of America's second largest industry, and who are a chief source of the new capital required by its continued growth.

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A Great Name in Oil

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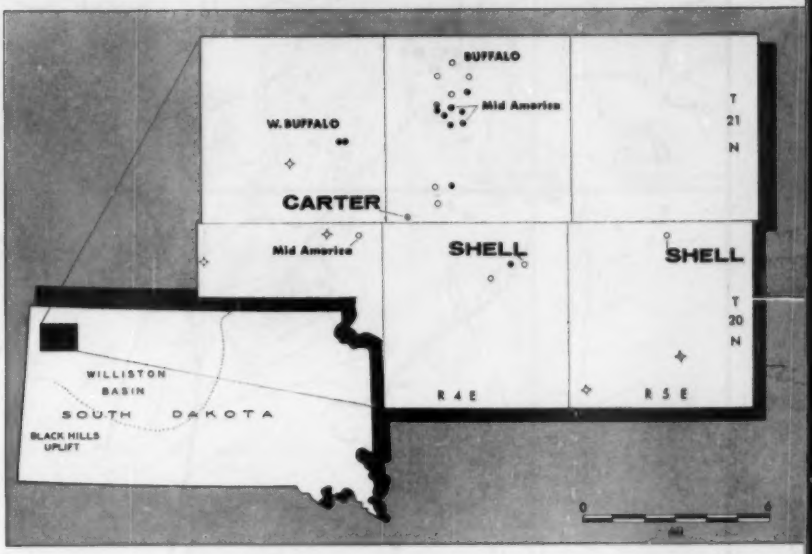
Rigs whirl in South Dakota at record pace

BY FRANK J. GARDNER



SOUTH DAKOTA is undergoing the busiest drilling campaign in its history in the vicinity of Buffalo field. New wildcat announcements now come in bunches, as more operators move into the area.

PERCHED on the south edge of the Williston basin, South Dakota has been sadly neglected by the oil hunter since the original Williston oil strike in 1951.

One small field was found at Buffalo in 1954, and no other success stemmed from sporadic wildcatting until 1958, when Clarkson & Schlaijker found the "West Buffalo" pool at the 1 Government, a 228-bbl. discovery based on a nontechnical location. Production in both areas comes from Red River-Ordovician rocks at depths of 8,500 to 8,700 ft. Both are in Harding County.

From a slow start . . . Some of this neglect resulted from poor performance of the early Buffalo wells and from disappointment in the few exploratory holes that were drilled. The initial Buffalo discovery was Shell Oil Co. 1 State, a 129-bbl. well drilled on seismic dope; a dilly-dally development program saw only one more well in 1954, no more in 1955 or 1956, and finally a third one in 1957. In 1958, Mid-America Minerals entered the field and drilled the fourth producer at Buffalo.

So far, Harding County had been "Shell's corner." What really jolted new life into the area was the West Buffalo hit last December. Since then, new operators have moved into the play, notably Carter Oil Co. Also, new leapfrog successes south of the main field have drawn attention to much greater possibility than had previously been apparent.

Giant strides . . . Shell's 14-28 Haivala (Section 28-21n-4e) was a long stepout success to the south of Buffalo; it is within the official field limits as outlined by the state. Then, just last month, Shell did it again. The 1 Tilus, in Section 11-20n-4e, was finished as a new-field discovery for 111 bbl. of oil and (typical of Red River wells around here) 109 bbl. of water per day; pay zone in Red River was 8,365-67 ft.

To new projects . . . And so the picture changes. As a result of the two southward hits and a confirmation of the West Buffalo pool, South Dakota's northwestern corner is a busy one. Last week, six new locations were announced for Harding County; five of them lie within the confines of the map shown here. In addition to these new operations, we find 7 rigs active on drilling wells and 3 previously announced locations not yet drilling . . . a total of 16 projects for this county, and certainly a record pace of activity.

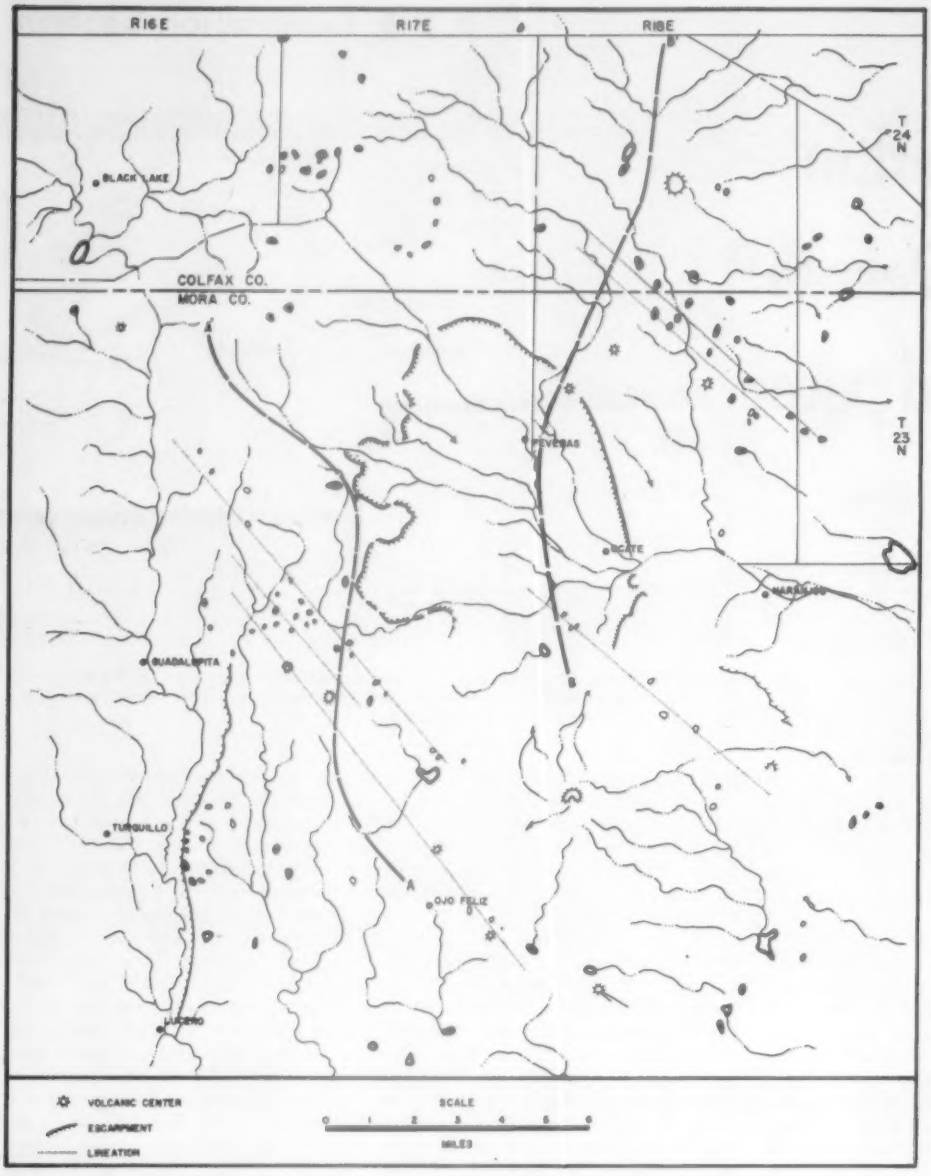
Two interesting developments have occurred during the past few days. One was the abandonment of a key wildcat at Shell 32-31 Nieme "B" in Section 31-20n-5e. The other was a slight show of oil at Carter's 1 Travers (Section 31-21n-4e), southwest of Shell's Haivala extension of Buffalo field. The Shell failure had shows of Red River oil at 8,374-76 ft., but failed to make the grade; it went to total depth 8,386 ft. The Carter well cored oil shows in Red River at 8,360-70 ft. and has run casing to total depth 8,440 ft. as a result.

Taking a closer look at the five new locations, we find two of them lying between the Shell-Haivala "extension" well and the Carter indicator, two offsetting the Shell-Tilus discovery, and one (Mid-America 1 Gardner) as a 1½-mile southwest stepout from the Carter well; all but the last-named are Shell operations. This kind of fill-in work should soon show which way the ball is going to bounce.

Among the active tests, one of the most significant should be Shell's 12-3B Brown, in Section 3-20n-5e (east edge of map). This wildcat lies far to the east of previous drilling, and if it should hit, a big field will be in the making here. It's now running intermediate casing with current total depth 5,800 ft.; the contract calls for an 8,600-ft. hole.

Moving up for a look at Buffalo field proper, we see Shell with three locations staked on the north flank, and two drilling. Mid-America is in the final finishing stages at two field wells in Section 16-20n-4e . . . again, water flows nearly equal and sometimes exceed the oil flow.

After a 50-year search, South Dakotans may yet find that big oil field they've wanted so badly. Before the debut of Williston, most drilling was shallow and centered about the Black Hills uplift in the southwest corner of the state; some semicommercial success was found there. But the big oil must surely lie within the Williston contours.



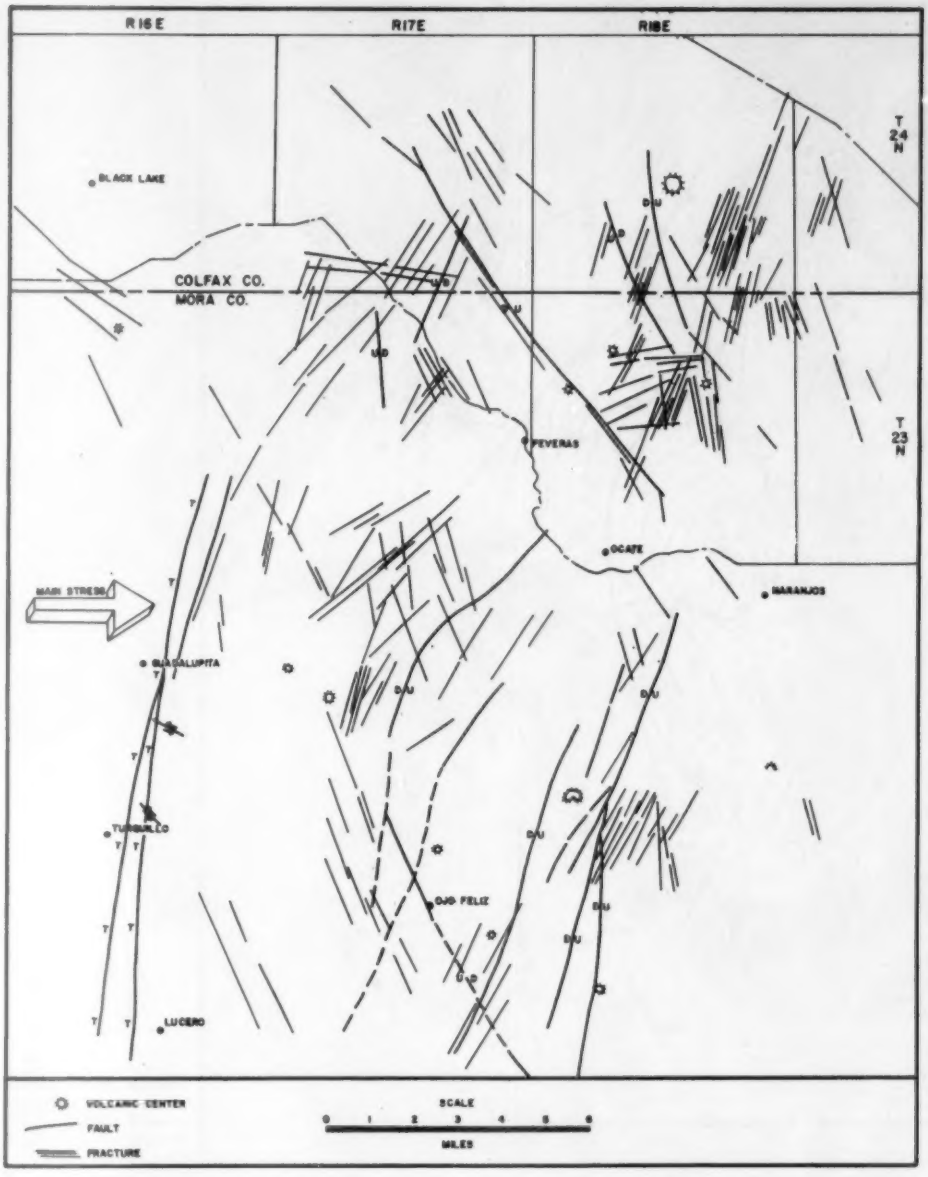
THREE TYPES of drainage patterns are evident: rectangular, parallel, and dendritic to radial in the western, central, and eastern sectors, respectively. Fig. 1.

Drainage and geomorphic map is first step in evaluating how . . .

Photogeology gives clues to

Meet the authors . . .

H. Gassaway Brown III (left) and Lowell E. Bogart specialize in photogeology with the firm of Beard & Bogart, consulting geologists, Albuquerque, N. M. Bogart, a partner, has a BA from Wooster (Ohio), and a MS in geology from University of New Mexico. Formerly he worked with Standard of Texas. Brown received his BA in geology from Cornell University and before joining this firm worked for the Government and in private industry.



FAULT - FRACTURE map suggests a north - south anticline. The more dominant northeast - southwest trend overshadows the secondary northwest - southeast trend in this shear couple. Fig. 2.

New Mexico oil prospects

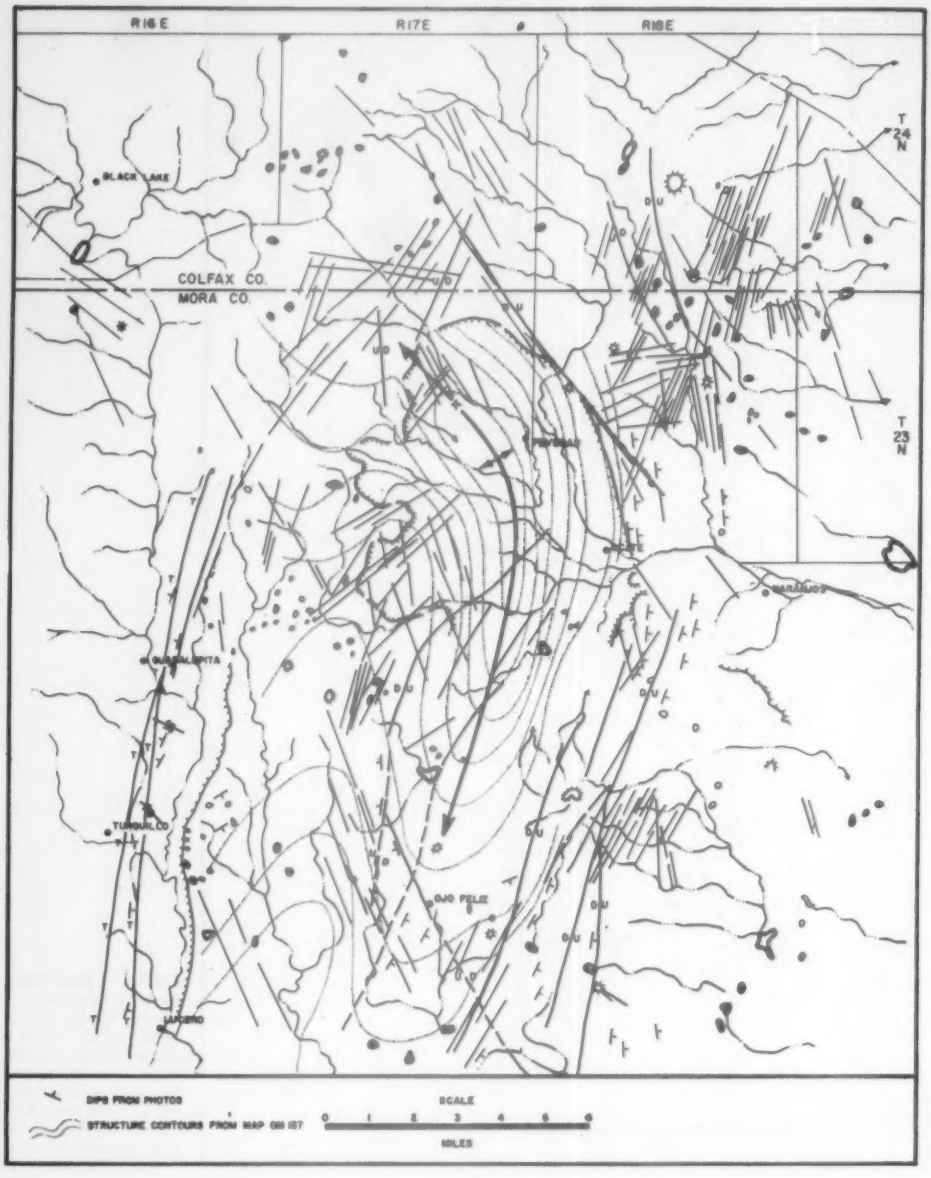
SEVERAL criteria are useful in determining structural attitudes through the use of photogeology.

It is often necessary to obtain surface geologic data rapidly and accurately without visiting the area of study. In some cases an area may be quite remote or inaccessible. Photogeologic reconnaissance is the tool which best meets this need.

The Ocate area in Mora County, New Mexico, illustrates mapping of structural criteria in an area largely covered by volcanics. These volcanics are Quaternary in age, consisting of basalt flows eminating from several vents. Most stratigraphic and structural data is therefore masked. Nevertheless, the basalt-covered areas show geomorphic characteristics and fault-fracture patterns useful in making a structural analysis. These criteria, often obscure, can be used in structural analysis.

The area studied is located in the northwest corner of Mora County, New Mexico, and includes Township 21n through Township 24n and Range 16e through Range 19e. Approximate bounding lines are 36° 00′—36° 22′ N. Lat. and 104° 54′—105° 17′ W. Long.

The first step in a study of this type is careful stereoscopic examination of photography and annotation of detailed drainage, faults, fractures, bed attitudes and any geomorphic indications of structure. This data is compiled on a base map of the project.



SUPERIMPOSING data from Figs. 1 and 2 pinpoints position of anticline. Fig. 3.

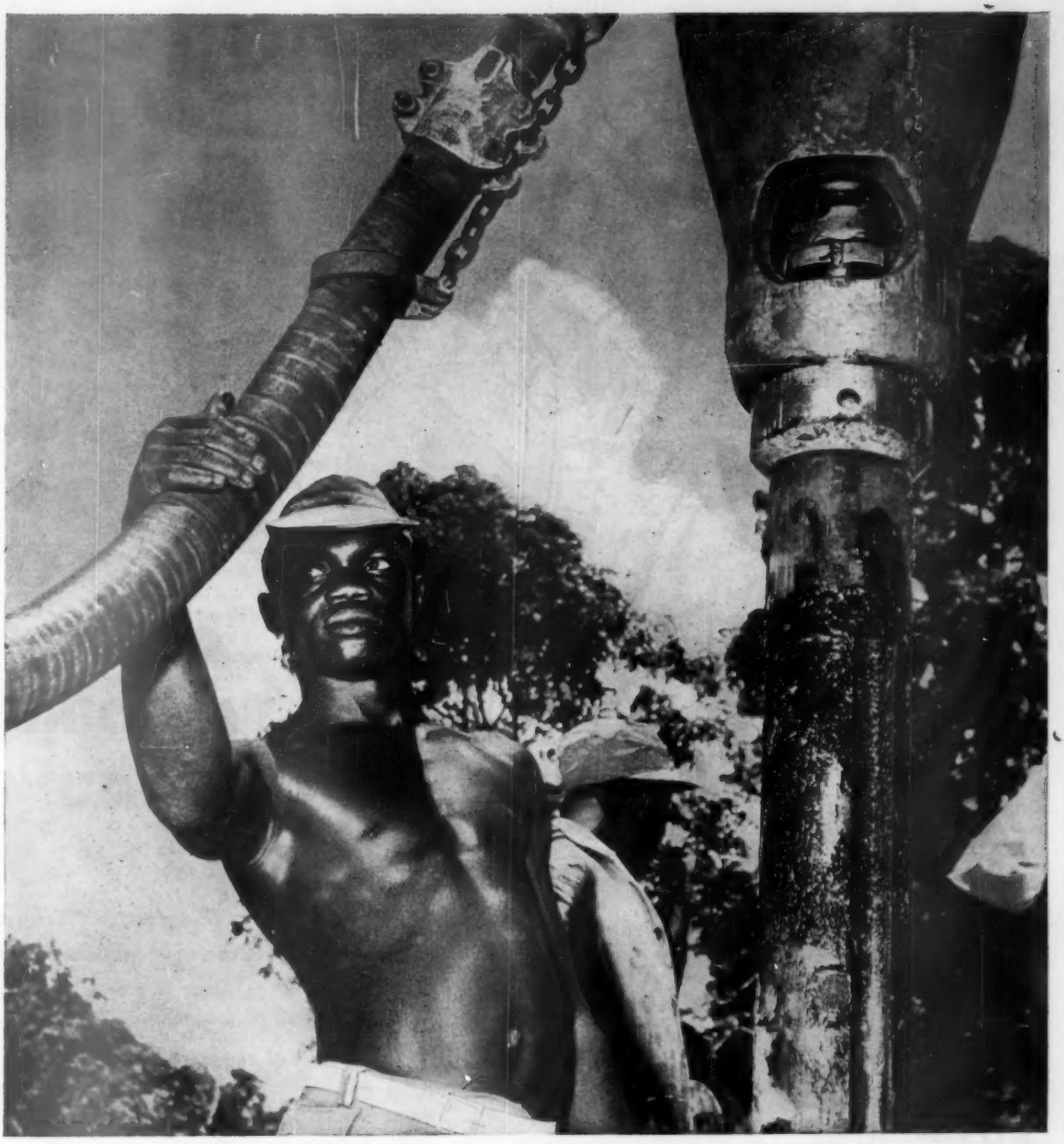
For this paper three maps were compiled: Fig. 1 shows drainage and physiography; Fig. 2 shows fault and fracture patterns; and Fig. 3 shows a combination of Figs. 1 and 2 with published data superimposed.

Drainage and physiography . . . Lines AA′ and BB′ separate three areas of different drainag type and pattern (Fig. 1). West of line AA′ drainage is characterized by a southward- flowing rectangular system of streams. The north-south escarpment in this area separates a system of hogbacks and strike valleys on the west from a gently sloping upland mesa on the east. The basalt-covered uplands are dotted with numerous small lakes. The drainage and physiographic character of the area, then, suggests westerly dipping beds increasing in magnitude to the west. The strike valleys imply steep dips and probably faulting.

Between lines AA′ and BB′ drainage is predominantly southeasterly forming a system of parallel streams. Line BB′ is one of drainage diversion where several streams flow into a fewer number of channels. This can be suggestive of faulting or uniform dip on one limb of a structure. Physiographically the area is a wide-open valley bounded by escarpments. The escarpment is the edge of a lake-dotted basalt upland which surrounds the valley. This picture suggests, then, a denuded structurally high area, or breeched anticline. Observed drainage diversions add strength to this possibility.

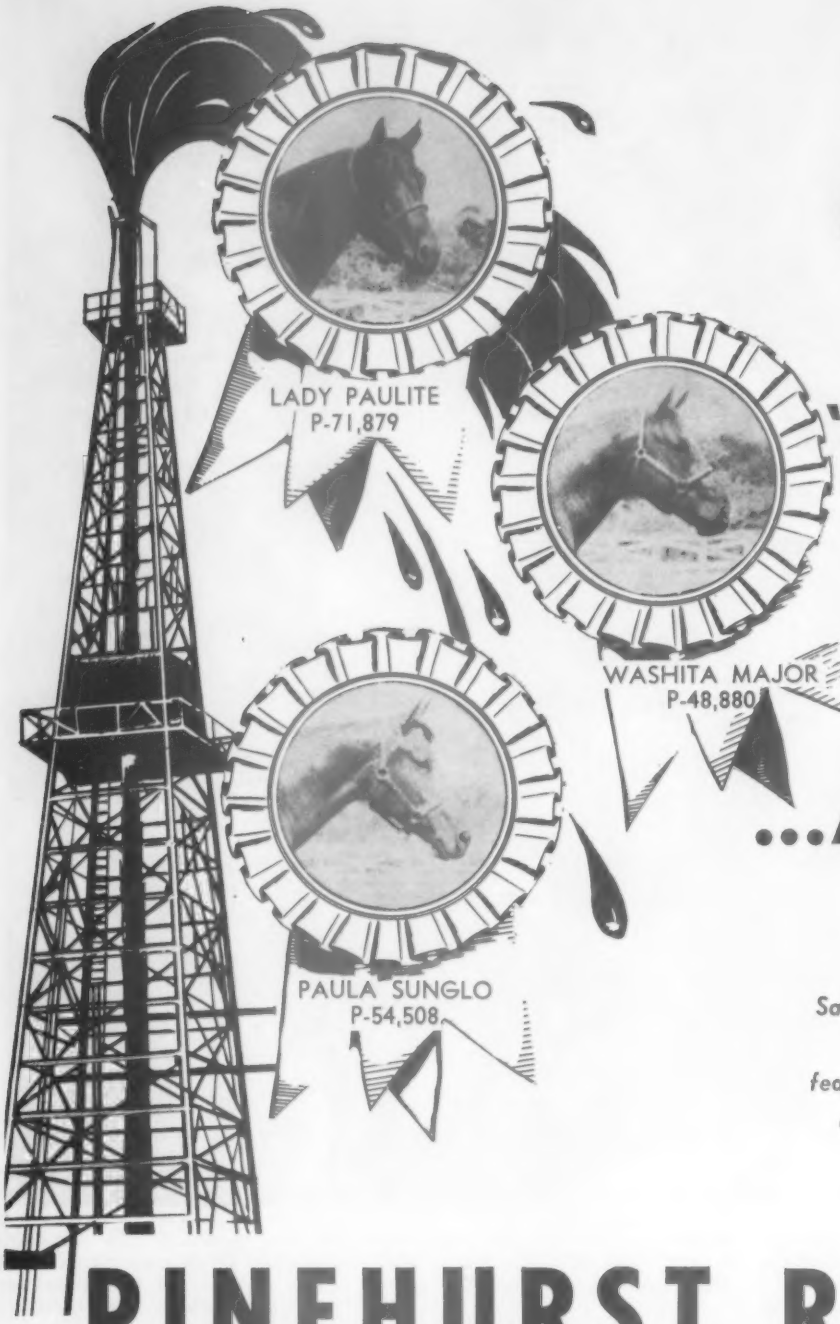
The area east of line BB′ is drained by southerly and easterly flowing system of dendritic streams. Physiographically the area is a volcanic-covered upland formed by basalt from numerous vents. Small lakes dot the gently eastward sloping surface. Both drainage and physiographic character suggest uniform dip to the east.

In summary, the regional picture shows a central valley bounded by a scarp-edged upland of volcanic cones and rugged topography. Note that several of the numerous upland lakes appear to follow lineations in a north-



Tanganyika. A Failing 2500 test rig. BP is currently engaged in the search for new sources of oil in 6 far separated regions of the continent of Africa.

BP



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west-southeast direction. It will be seen later that this is one of the major directions in the structural grain. The combination of drainage and physiography suggests uplift in the valley area contained between lines AA′ and BB′.

Faults and fractures . . . The immediate impression from Fig. 2 is the twofold direction of fault and fracture pattern: northwest-southeast and northeast-southwest. Similarly the faults parallel the fracture directions. This is to be expected since the same force is the likely cause for both, the result ranging from imperceptible movement to rupture. Greatest concentration of fractures occurs in the northeast part of the area on the south flank of a major volcanic peak. Volcanic vents are roughly aligned parallel to major fault traces. If one dominant fracture direction can be picked, it would be the northeast-southwest direction.

From these first impressions it is apparent that the fault-fracture pattern forms a diamond-shaped parallelogram elongated in a north-south direction. This indicates the maximum stress direction to be east-west provided the pattern shown is the result of a shear couple. This, then, suggests a compresisonal fold parallel to and centered about the north-south axis of the parallelogram. The major fault and fracture directions are necessarily shear lines.

Strike-slip movement on the faults cannot be mapped on photos in most cases but evidence suggests this interpretation. The thrust faults along the west side of the area were not mapped per se on the photography but taken from published work. The significant point is that the thrust plate is on the west side, indicating the force from that direction. This supports the interpretation made from the fracture pattern.

Relative movement was determined on all major faults except one. Note that all faults forming the parallelogram have their downthrown side toward the center of the parallelogram, with only one exception. Applying the rules of epianticlinal faulting to this allows postulation of an anticline within the parallelogram. This is the "keystone" block principle of the downthrown side being toward the anticline crest.

Superimposition of data . . . The third map (Fig. 3) shows the combination of data presented in Figs. 1 and 2 with the addition of dips and strikes from photos and structure contours from a published source, USGS OM 137. Continental Oil Co. contributed the dry-hole symbol on the anticlinal axis.

Only small scattered outcrops of sedimentary rock are present to provide structural data. Dips and strikes shown indicate areas of sedimentary rock; thus it is evident that most of the sedimentary rocks are volcanic-covered or obscured by alluvium.

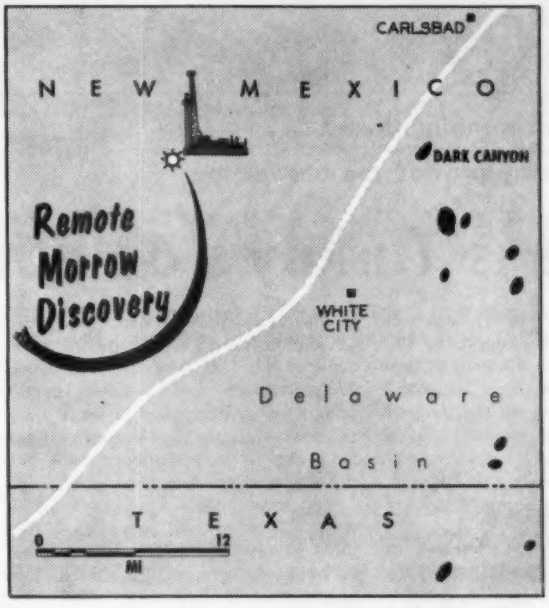
This map (Fig. 3) illustrates the combination of criteria obtained through photogeologic analysis and how it fits published structural contours. Note the pattern of faults around the anticline as well as its relation to the erosional basalt scarp. This map shows most of the fractures on the flanks of the anticline rather than on the crest. Perhaps only an apparent relationship exists since the crest is located in a wide alluviated valley where fractures may not be evident.

Summary

A photogeologic study of the volcanic-covered area centered around Ocate, N. M., shows that drainage pattern, geomorphology, fracture pattern and fault pattern can be helpful in making a structural analysis of the area. Published field work substantiates data obtained entirely from aerial photographs.

Acknowledgment

The authors wish to thank the Standard Oil Co. of Texas for its assistance in providing AMS high-altitude photography which was used in this study.



REMOTE Morrow Pennsylvanian gas production comes to southwestern Eddy County in Southeast New Mexico.

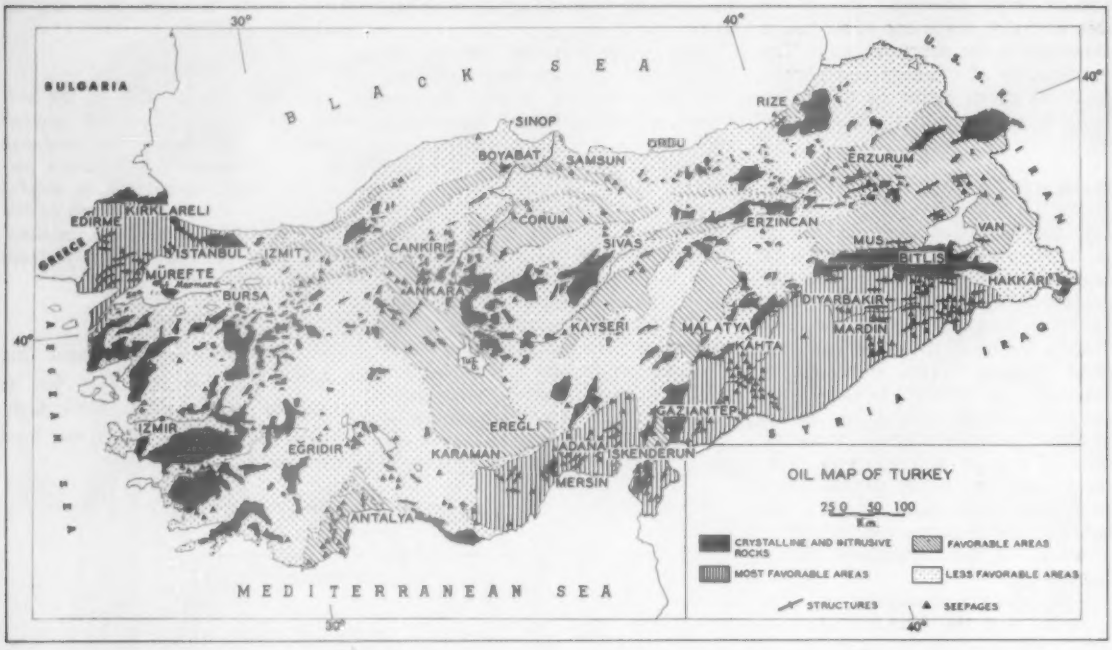
In southern New Mexico . . .

Rank wildcat taps Morrow

ONE of the few Morrow Pennsylvanian producers in Southeast New Mexico is Humble Oil & Refining Co. 1 Bandana Point Unit, 13 miles northwest of White City in the southwestern part of Eddy County.

Testing continues at this important remote discovery. Gas flowed at the rate of 1,541 M.c.f.d. from perforations at 9,782-96 ft. Flow was through ¼-in. choke. Top of the Ellenburger is 12,070 ft. in this southern New Mexico well.

Location of this wildcat is about 15 miles west of Dark Canyon field in 13-23s-23e. There is no production in the area. The well lies on the shelf area just outside the Delaware basin, and is the westernmost production in the Permian basin proper. Morrow nomenclature has been in use in Southeast New Mexico for only a few years. There are very few fields in the state with production from the Morrow which is Lower Pennsylvanian in age.



Favorable areas in the northwest and southeast may provide the answer to:

Where is Turkey's oil potential?

BY CAHIT ERENTOZ and ZATI TERNEK
Geological Division,
Institute of Mineral Research & Exploration,
Ankara, Turkey

OIL POSSIBILITIES in Turkey will be considered in this report in the order of importance of sedimentary deposits in various basins.

This paper is based on the data of the geological map recently completed on the scale of 1/100,000 and on the geological surveys so far carried out. The opinions presented are our own only.

The first oil-exploration surveys in Turkey began at the close of the 19th century and since 1926 the Turkish Government has had some reconnaissance drilling conducted in Thrace, Adana, Iskenderun, Gaziantep, and Mardin.

The Mining Research & Exploration Institute of Turkey has handled the oil exploration and surveys, and has found exploitable oil horizons in the Raman and Garzan structures. In line with these activities, the Institute has executed general and detailed geological and geophysical surveys in certain areas.

Under the petroleum law promulgated in 1954, licenses have been so far granted to 21 Turkish and foreign oil companies to search for oil in Turkey. These companies have availed themselves of the surveys and reports of the Institute and proceeded with oil exploration. The Institute is prospecting for oil and is conducting geological and geophysical surveys with its own geologists in such areas as Sivas-Malatya-Mus-Van which are held closed in accordance with the provisions of the petroleum law.

This is an abridgment of a paper read at 1959 Fifth World Petroleum Congress.

The most promising areas are seen where there are oil seepages. Structures favorable for the existence of oil in these areas and the sedimentary conditions are important. Producing areas come under this heading and cover some 121,688 sq. km.

Promising areas are those whose sedimentary conditions are favorable for the existence of oil, where there are also oil seepages, and which cover approximately 164,565 sq. km.

The Most Promising Areas

Structures favorable for the accumulation of oil are found in these areas. Oil seepages in geologic formations of various horizons are also found here. The thickness of the deposits and the facies are favorable, too. The areas are as follows:

- Southeastern Anatolia district
- Antakya-Iskenderun district
- Adana-Mersin-Mut district
- Thrace district.

Southeastern Anatolia district . . . This district is located between the metamorphic Bitlis Massif in the north, the Anti-Taurus mountains in the northwest, the south bend interlinking the Anti-Taurus mountains in the west, and the Arabian block. In this district lie the oil-producing Raman and Garzan oil fields.

The Cilo, Giri, Tanin, and Cudi heights, forming the Hakkari mountains and extending as a strip east of the basin following the orogenic zone south of the Bitlis Massif, are of paramount importance as they furnish data on the deeper formations of this area. In this district the dolomitic limestone horizons, partly massive and with hydrocarbon zones above the Permo-Carboniferous (Tanin formation, 2,000 m. thick), also contain bituminous limestone-shales occasionally in the Devonian and the Triassic (Goyan formation). These correspond to the massive limestones which constitute the oil horizon in the Raman oil wells. There are impregnations of

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hydrocarbons in the sandstone beds of the Devonian rocks which are the oldest in the Hacertum Dagi heights, north of Diyarbakir. This is the only hydrocarbon-bearing zone in the lower part of the Paleozoic.

Above the Carboniferous, Permian, and Triassic massive limestones, Jurassic-Maestrichtian age, with bitumen accumulations, have always shown lithologic differences due to lateral and vertical facies changes in various parts of the district. These limestones vary in thickness 900 m. as shown by the Raman drilling operations; 1,000 m. in the Kentalan drilling, and 6,000 m. at Gercüs. On the other hand, their thickness varies between 400-1,000 m. among outcrops and reaches some 2,000 m. in the Cudi heights at Hakkari.

These massive limestones, which may serve as reservoir rock, are overlain by the Kermav formation of Upper Maestrichtian-Lower Paleocene age, which generally contains shale. The thickness of these formations varies between 300 and 800-900 m. The coarse, clastic, and reddish shale sequence having the features of a regressive facies and overlying the latter series is the Gercüs formation, Ypresian in age.

In the Adiyaman-Kahta-Urfa-Gaziantep districts, each of which lies in this basin, there has been thick and continuous sedimentation ranging from Paleozoic to Miocene as observed in eastern Anatolia. However, facies changes can be seen in certain beds. The Miocene formations above the Lutetian Midyat limestones show another characteristic aspect in this district. In the drilling operations conducted at Kahta, some oil seepages were observed, particularly in the massive limestones where there is a petroliferous horizon 600 m. thick. Again, during drilling at 1,300 m. at Gaziantep, an asphalt horizon of 25 m. was crossed in massive limestones 400 m. in thickness.

Despite the fact that important oil fields have been found in the Asmari limestones (these correspond to the Midyat limestones) which lie outside the southern boundaries of Turkey, no oil could be seen in the Midyat limestones in Turkey as they are void of good caprock. In southeastern Anatolia as well as Iskenderun oil fields are likely to be found in the marine Miocene layers.

This is also especially true for the Miocene or Eocene formations situated under basalt and thick Plio-Quarternary levels widespread in the neighborhood of Kiyarbakir. Again this may hold for the Miocene and particularly the Eocene in the Cizre plain, as there exists a rather thick capping layer. Finally, favorable conditions might exist in this district in the Lower Mesozoic, and for the Paleozoic. In the eastern portions of the basin, near fault zones north of Cizre, oil may be found provided there are traps for petroliferous accumulations.

Owing to the existence of various petroliferous horizons and of the series of favorable source clays and marls in the basin whose depths reach some 6,000-7,000 m., oil may be expected to be found in these districts in Devonian to Miocene rocks.

Antakya-Iskenderun district . . . The end of the southern bend of the Anti-Taurus mountains constitutes the Amanos mountains which extend to the island of Cyprus. The Amanos mountains resemble a horst between two low flatlands. This mountain range is locally broken, dislocated, or cut by stepped faults due to strong tectonic movements. The main Paleozoic nucleus is located in the north, whereas the Mesozoic is widespread in this district. The Paleozoic and the Mesozoic are separated by an unconformity.

The greenstone complex plays an important part at Kizildag, over which the Maestrichtian transgresses. The greenstones are generally massive and plaquetted limestones. In the reef portions of the underlying dark gray, blackish, limestone series and in the thin plaquetted limestone series overlying the greenstone series, hydrocarbon seepages have been observed.

The thickness of these limestones is more than 1,500 m. These limestones lie under serpentines 1,00-3,000 m. thick. Among the White Eocene limestones only one asphalt impregnation has been seen.

During an oil-drilling operation carried out at Arsuz, Iskenderun, the drilling reached a depth of 726 m. and crude oil was found in the Helvetian sandstones and limestones, 50-60 m. thick and containing microorganisms in abundance. This thickness varies from place to place. In some oil drilling done at Iskenderun, hydrocarbon gas was observed. Among these Helvetian sandstones and limestones, a marl series, Tortonian and Pliocene in age, was 1,320 m. thick.

In another oil well drilled at Iskenderun the drilling reached 1,000 m. and was discontinued in serpentine. However, it would not be useless to test the sedimentary strata under the serpentine, which is older than the Cenonian. The Iskenderun basin deepens to the north and towards the sea in the west. In these lower parts, oil structures can also be expected in the sea.

Adana-Mersin-Mut district . . . The neighborhood of Adana and Mersin, south of the Taurus mountains, bears the characteristics of a deep subsidence basin covered by Miocene strata. The characteristic features of sedimentary rocks together with oil seepages make this district particularly important.

The substratum of the district is found in the Taurus mountains in the south, in the Misis mountains, and in certain windows. All the old geological formations surround this district; while the Mesozoic with the Cretaceous and the Lower Tertiary strata are spread over limited areas, the Miocene strata cover the basin. These strata are very characteristic regarding petroleum and sedimentary deposits. The reef, biohermal, sandy, and marly limestones overlying the basal conglomerates and the Middle Eocene sandstone sequence show the lateral and vertical facies changes in the basin. These increase in number from north to south. The Burdigalian formations, seen as limestone at the basin edges, vary to sandstones and shales centrally, their thickness being 500-1,000 m. Both the Lower and Middle Miocene beds show the considerable thickness of 3,000-5,000 m.

With the exception of the oil seepages seen in the Paleozoic and in the serpentines in this district, the oil seepages in the Lower and in the Middle Miocene are encouraging because of the fact that there are continuous Tertiary deposits with thicknesses and quality favorable for petroleum in the basin; also there are structures, buried hills, stratigraphic, and structural traps for oil. Hence this district is one of the most promising areas to find oil.

Thrace district . . . This district which is surrounded by the substratum of the old massifs has long been a theater of oil-exploration operations because of its favorable and continuous sedimentary deposits, oil seepages, and structures. Rocks ranging from the Upper Cretaceous to the Upper Neogene are found in this district. The Eocene, Oligocene, and Miocene are important for oil. Following the marl sequence, 1,000 m. thick, are detritic sandstones 50 m. thick and Lutetian reef limestones with a thickness of 200-500 m. The Eocene-Oligocene flysch on top displays a thickness of 2,500-3,000 m. Sediments with the enormous thickness of 10,000 m. having been deposited in a narrow basin indicate that the district bears the characteristic of a subsidence. East of the basin, between the Cekmace lakes, the Eocene lines north northwest-south southeast. At Tekirdag-Sarkoy

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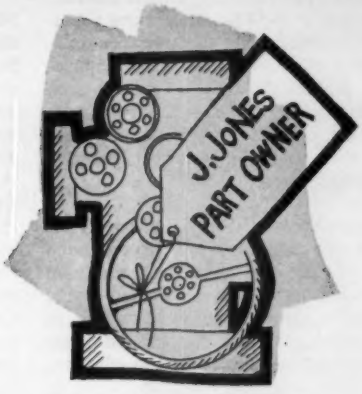

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the Eocene-Oligocene-Miocene, striking northwest-southeast (the same lying northeast-southwest to the west and in the Ergene basin) has east-west-oriented anticlines and synclines, forming as a whole a virgation.

In the Thrace district, bitumen and oil have been found only in the Middle Miocene and the Sarmatian beds. Apart from it, Miocene oil and gas have been observed in drillings made at Sarkoy, Mürefte.

The Promising Areas

The districts whose sedimentary deposits are satisfactory for the accumulation of oil are covered under this heading. In some parts of this district little reconnaissance or exploratory drilling has been conducted. These districts are as follows:

- Van-Mus-Hinis-Malazgirt
- Sivas-Erzincan-Erzurum
- Rize
- Malatya
- Corum-Cankiri
- Ankara-Bingol-Eregli (konya)
- Antalya
- Niksar - Boyabat - Kastamonu - Ismit strip.

Van-Mus-Hinis-Malazgirt district . . . This area is in a large basin between the Bitlis and Paleozoic Massifs in the north. That the sedimentary deposits are favorable for the accumulation of oil, that the seepages are numerous, and that there exist in certain places structures, rank this district as the first of the promising areas for oil. Geologists of the MTA Institute are conducting facies studies in the area.

Sivas-Erzincan-Erzurum district . . . The important prospective rocks of this district, so far as the sedimentaries deposits are concerned, lie west of the Erzincan-Erzurum. The Mesozoic in its entirety lies unconformably over the Paleozoic and shows a thickness of 6,000-7,000 m.

Some oil seepages have been observed in the Miocene beds. The existence of oil seepages and of thick and continuous sedimentary deposits in this district are valuable evidences.

Rize district . . . Evidences of hydrocarbons originating from three different places in the eastern Black Sea, Rize, and Cayeli districts, make this area important for oil exploration. Seepages and the existence of structures in this area's marine strata make it necessary to include this district among the promising oil-hunting grounds.

Malatya district . . . Owing to the existence of suitable structures and sedimentary deposits of the proper kinds, and of evidence of seepages, as well as consideration of the fact that the Eocene, particularly the Upper Cretaceous and partly the Miocene limestones have reef characteristics, we may consider oil possibilities good. The existence of marly beds, or rocks where marls and sandstones alternate —and are sufficiently thick to cap possible oil reservoirs—should make this area attractive to oil exploration.

Corum-Cankiri district . . . Sections of the Cretaceous rocks, remote from basaltic eruptions, the Middle Eocene, and part of the Oligocene, have necessary characteristics for the accumulation of oil in this area. Gas seepages and asphalt deposits have been seen in this district. Also, salt springs suggest the presence of salt domes, making this area considerably attractive for exploration.

Ankara-Tuzlugol-Eregli district . . . This area is a large basin surrounded by the Elmadag Paleozoic series in the north, the Kirsehir metamorphic series in the east, the Taurus belt in the south, and the Sultan and Emir mountains in the west. Although there are favorable structures and oil seeps in this basin, the structures are generally faulted and broken, and since aquifers exist in certain places, these districts could be included among the promising areas.

Antalya district . . . South of Antalya, at the contact of greenstones with the Cretaceous limestones, and in the Mesozoic limestones, there are oil seeps and some favorable structures in the district which render it promising for oil.

Niksar-Boyabat-Kastamonu-Izmit belt district . . . This belt parallels the Black Sea coast line, and in the south extends east and west as a Tertiary corridor. The important area in this belt is the Boyaban-Ekinviran sector. There are locally some oil seeps in this belt. Seeps are found in the Upper Cretaceous flysch. The lower levels of the Eocene and the Oligocene beds over this flysch serve as a good oil reservoir. There are also some promising structures in this district. The Cretaceous-Oligocene deposits are favorable for oil because of their thickness.

New Mexico geologists hold meet

The New Mexico Geological Society will sponsor its tenth annual field conference in the West Central New Mexico area on October 15, 16, and 17. The trip will begin at Socorro with overnight stops at Grants and Gallup, and disband in Socorro on October 17.

Purpose of the field trip is to examine outcropping formations of Pennsylvania through Tertiary sediments and compare them with their subsurface equivalents.

The trip starts in the Rio Grande graben at Socorro. From Kelly the route will pass across the San Augustine Plains, through the Tertiary Datil volcanics, to the Red Lake area where excellent exposures of Triassic and Upper Cretaceous beds will be seen. It is in this area that Spanel and Heinze are drilling two Pennsylvanian wildcat tests in 17-4n-5w on the Lawson anticline and in 5-5n-7w on the Half Dome structure. From this area to Grants the Jurassic wedgeout can be seen as well as the relationship of deposition of a portion of the upper Cretaceous section including the Dakota, Tres Hermanos and Gallup sandstones.

The second day of the field trip will be centered around the Zuni uplift.

From Inscription Rock at El Morro exposures of Jurassic and Dakota can be seen. Between El Morro and Gallup the trip will pass across the hogback on the southwest side of the Zuni uplift and exposures of the Chinle through the Gallup sandstone can be observed. As the trip crosses the axis of the uplift, formations down to the Glorieta sandstone are exposed.

The route on the final day of the conference is south out of Gallup to Salt Lake, where the stratigraphy of the Tertiary, Upper Cretaceous, Jurassic, and Triassic can be compared with what was seen the previous 2 days. From Salt Lake to Socorro the Datil volcanics and the San Augustine Plains again will be crossed. The conference will end in Socorro.

The field conference will be conducted in a portion of the state where no commercial oil or gas production exists. The above-mentioned Pennsylvanian tests which are now drilling could possibly forecast the activity in this area. A number of companies have large holdings in this area and several have indicated plans for drilling. Spanel and Heinze are to drill another Pennsylvanian test and Southland Royalty, Continental Oil Co. and Sun Oil Co. plan to drill Pennsylvanian or Precambrian wildcats later this year.

Persons desiring additional information for attendance should write to: R. E. Ostrander, 245-A Korber Bldg., Albuquerque.

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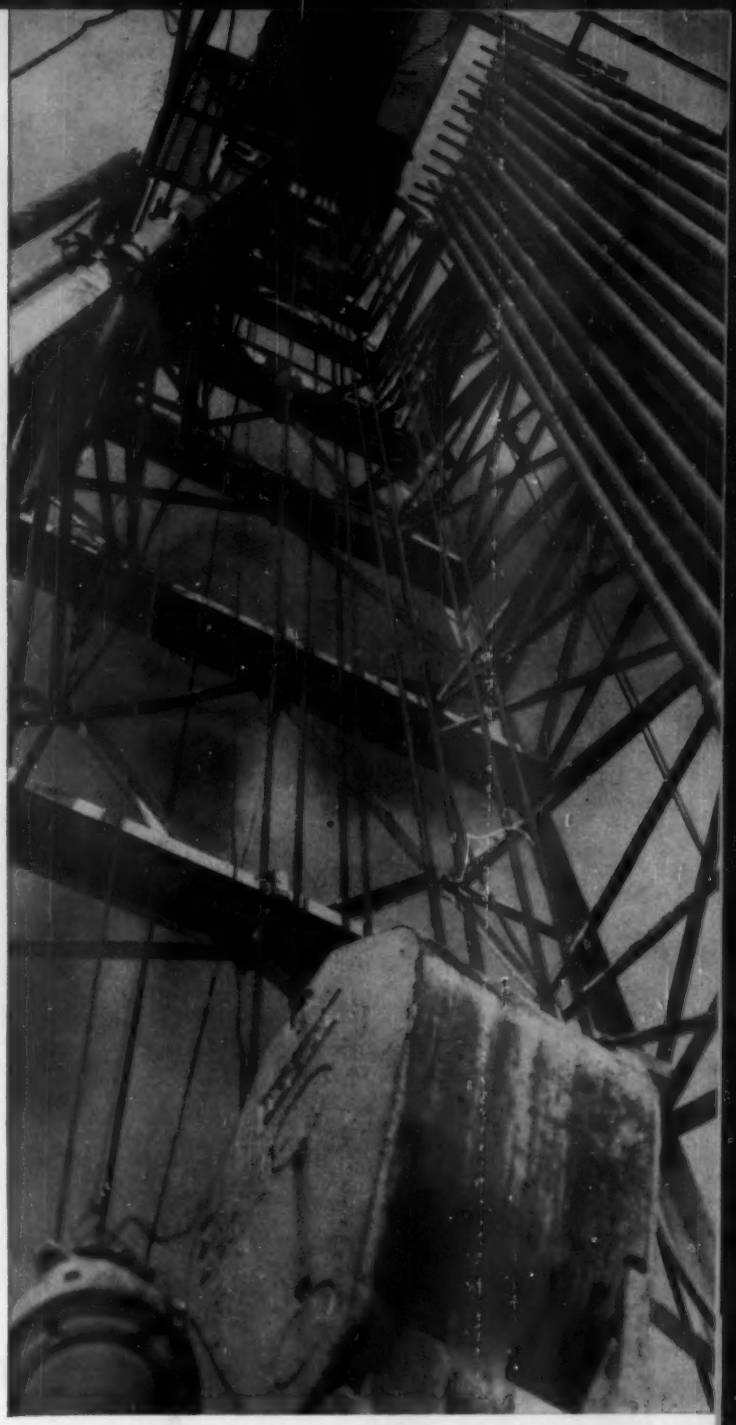

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In Alberta . . .

Canadian depth record may fall

IN ALBERTA, Shell Oil Co. of Canada's most recent staking in the Waterton Park gas field in the extreme southwest corner of the province will in all probability rewrite the western Canada drilling record books sometime in early 1960. A new deep-pool wildcat was announced early in September. The venture is scheduled as a 16,500-ft. probe of the D3 zone of Devonian production possibilities at Waterton Park. And, if carried to that projected depth it will better any previous drilling in Canada by over 1,200 ft.

Current depth record holder is the Texaco-N.F.A. 8-28-60-3 Simonette River (LSD 8, 28-60-3w6), exploratory test that was drilled in 1958 to total depth of 15,283 ft. Lying about 200 miles west of Edmonton and some 385 miles north-northwest of the new Waterton location the deep test backed by Texaco, British American, Shell, and Mobil was dry and consequently abandoned.

Scheduled to start immediately and be drilled with Shell-owned rotary tools this well is in one of Canada's most prolific gas-producing areas. This particular region of southwest Alberta is 120 miles due south of Calgary and just 15 miles north of the Alberta-Montana border. It has not yet been given field classification by the province's Oil & Gas Conservation Board but it ranks in importance with nearby Pincher Creek as one of the west's largest gas reserves. Pincher Creek incidentally is rated with recoverable gas reserves of 1.8 trillion cubic feet.

Although not yet fully delineated the Waterton field has been proved to extend in a north-northwest south-southeasterly direction for a distance of 21 miles. The Mississippian contains the field's major proved reserves of gas but an upper zone in the Devonian also indicated commercial gas production at the most northerly well in the field. The D1 zone of Devonian gas well was drilled by Texaco Exploration Co. on LSD 6, 17-6-2w5. The most southerly gas well at Waterton lies in LSD 7-16-6-30w4. A recent gas success was made by British American Oil Co. at a wildcat 15 miles south-southeast of the presently proved limits of Waterton Park.

A second look at the possible record breaker, Shell 9, 6-12-4-1 Waterton, staked on LSD 6, 12-4-1w5 (ground elevation 5,032 ft.) shows it is situated 1¼ miles northeast of Shell's 2 Waterton Mississippian gasser, which was completed at 12,765 ft. The new well is just over 3 miles north of Shell's 3 (6-28) Waterton Mount Head zone oil strike. That nearby oil well came close to the drilling depth record by going to 15,205 ft. After encountering significant oil shows, as well as commercial Mississippian gas, it was completed as a potential oil producer. Production tests yielded oil in fair volume but also showed a high gas oil ratio. On flow tests it yielded light-gravity clean crude at the rate of 136 bbl. daily with a GOR of 3,250 cu. ft. per barrel. Shell drilled the Waterton Park field discovery hole in 1957 and since that time its almost continuous drilling program has been well rewarded. It has not yet drilled an unsuccessful test but has drilled and completed six successful Mississippian gas wells and the one potential oil well. Two other field development drillers are under way at present.

Gas from the field lies in close proximity to proposed gas export pipelines and is earmarked for sale to Alberta & Southern Gas Co. should

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that company's pending gas export application be approved. Shell's drilling program has been geared to provide the maximum quantities of proved reserves for Alberta & Southern at Waterton.

As well as searching for a new producing horizon the new deep test well will be using new drilling techniques pioneered by Shell in western Canada. Substantial footage at this test will probably be drilled with the turbodrill.

Meanwhile, this general region's reserves were boosted substantially by British American's gas strike at 11-31-1-25 Lookout Butte (LSD 11, 31-1-25w4). This discovery tested gas from the Mississippian in the interval 12,099 to 12,469 ft. at maximum rate of 7 M.M.c.f.d. In addition to being 15 miles south-southeast of Waterton Park gas field this new find is 9½ miles south of Pincher Creek gas field and 5½ miles north of the Montana state border.

Wildcatters head for Fraser Valley

IN CANADA Richfield Oil Corp. recently announced details on a new exploration project in the Lower British Columbia mainland.

The company recently completed land acquisitions which tie up over 200,000 acres in the Fraser Valley, lying immediately south and southeast of Vancouver city. The lands acquired include seven B.C. permits that were obtained from various companies and individuals. Under terms of the agreements the previous land holders were given undisclosed cash bonuses and also retained 3% override royalties on the rights. Richfield will now pay all rentals on the acreage and fulfill work commitments. Actually the firm has already commenced exploration on the rights and has a Western Geophysical Co. of Canada, Ltd., seismic crew engaged on exploration within one of the permits.

The lands acquired border on the Canada-U. S. boundary. Most easterly permit, No. 305, on which the seismic party is now working, was acquired from Key Oil & Gas Co., Ltd. It contains 34,400 acres. Permit No. 688, a 15,900-acre spread, adjoins the northwest corner of permit No. 305 and was also acquired from Key Oil & Gas. Permits 802 and 803 cover 54,332 acres and 57,641 acres respectively, and are on the west side of Richfield's block. They were obtained from A. J. Palmer and J. G. White, believed to be B.C. lumber operators. Permit No. 805 was acquired from Delta Oil & Gas and covers 19,714 acres. Permit No. 670,

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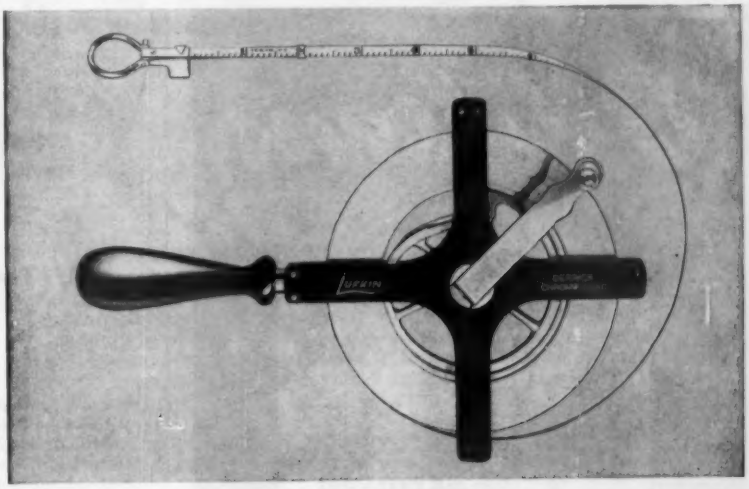

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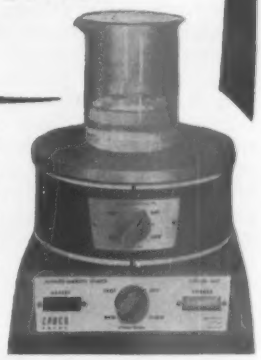

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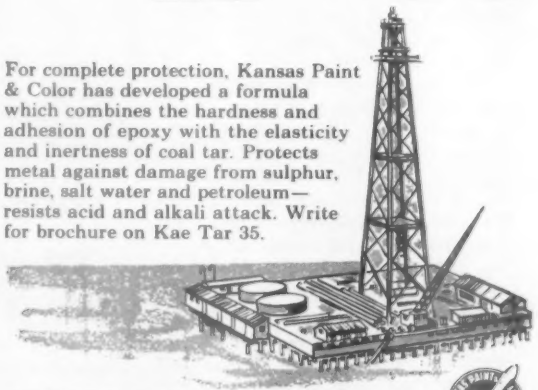

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comprised of 6,819 acres, was obtained from the group of Gulf Development Co., Big Horn Petroleum, Van Tor Oils, Royal Canadian Ventures, Peace River Petroleums, and Richwell Petroleums, Ltd., while permit No. 677 covering 18,000 acres came from White & Palmer, Big Horn, Van Tor, Royal Canadian Ventures, Peace River Petroleums, and Richwell.

Key Oil & Gas drilled an exploratory test on permit No. 305 previously. That deep test well was abandoned after reaching total depth of 7,842 ft. although it reportedly gave up numerous oil shows while drilling.

Colorado's Prowers gets first oil pay

FIRST OIL production for Prowers County in eastern Colorado is reported at a Skelly Oil Co. wildcat. The operator swabbed 72 bbl. of oil per day plus 34 bbl. of acid water at the 1 Bailey in C NE NE 3-26s-45w. Pump is being installed.

Recovery at this well is from Morrow Pennsylvanian sand at 5,027-36 ft. If successfully completed as an oil well, it would open first such production in this eastern Colorado county. Location is on the east side of the Las Animas arch in a county just west of the Kansas line. There is gas production 2 miles north of this well at 1 Bailey, an Excelsior Oil Co. 1958 workover strike in C NE SW 27-25s-45w.

Chances rated good for Washington strike

There are good possibilities of a new field discovery well in Washington's Grays Harbor County. Tideland Oil & Gas Corp. completed the second of two formation tests on the 1 Carlisle Estate in the Ocean City area, C SE 23-20n-12w.

The first test was made at 3,392-3,541 ft. The pay is thought to be the Blakeley equivalent and comparable to the producing zone at Ocean City field. Total zone is 211 ft. It includes a sand section of 127 ft. of which 80-90 ft. appears most prospective for good porosity and permeability.

Sand varies from very fine to fine-grained with small per cent medium-grained, hard and firm to locally friable quartz sand with local calcareous cement.

This is the first well drilled in the Ocean City area that has found sandstone horizons in the Oligocene-Miocene sections. For this reason, the well may have much greater possibilities for commercial production than other wells drilled in the area to date. Low porosity and permeability may still be the limiting factor for production of commercial value.

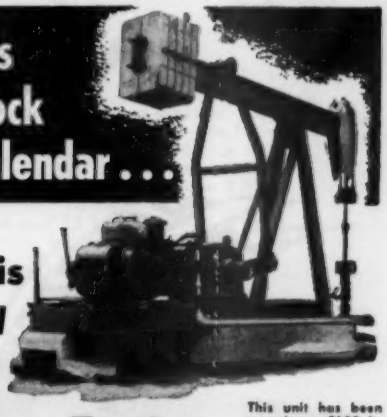
Long extension drilled to Texas' Lake Ferrell

A 2-mile south extension to Lake Ferrell field in western Marion County, East Texas, or a new discovery, has been completed for 112 bbl. of oil a day.

Trice Production Co., Longview, has completed its 1 Davis-Pelphrey for the above pumping potential, from Pettet perforations at 7,436-40 ft. Gas-oil ratio was 600:1, and gravity was 40.6°. Total depth was 7,559 ft., with casing run to 7,504 ft.

No. 1 Davis-Pelphrey is 12 miles west of Jefferson in John Baker Survey, A-35. It is 2 miles south of nearest Pettet production in Lake Ferrell field. Closest well in the field is Amerada Petroleum Corp. 1 Issie Segal, James Wimberly Survey, which completed in 1957 from Pettet pay at 7,333-45 ft. Flowing potential at Amerada's well was 541 bbl. of oil a day through ¼-in. choke.

Pumping Oil Wells Around the Clock and Around the Calendar . . .



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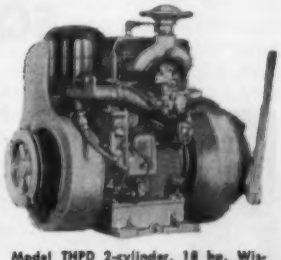
One of the outstanding features of this specially designed engine is its built-in HIGH MOMENTUM FACTOR. This is accomplished through the use of *multiple flywheels*. In addition to the standard cooling flywheel at the cranking end of the engine, an extra-heavy (80 lb.) flywheel is mounted on the take-off end of the crankshaft. This practically *triples* the Momentum Factor (WR^2).

Additionally, an oversize heavy-duty industrial dry type clutch is furnished as standard equipment. This assures long clutch life (to match the engine) under the terrific shock of constantly fluctuating loads that are encountered in oil well pumping.

This is only half of the story. For full details, about the Model THPD Wisconsin Engine, contact the Harley Sales Company's nearest office.



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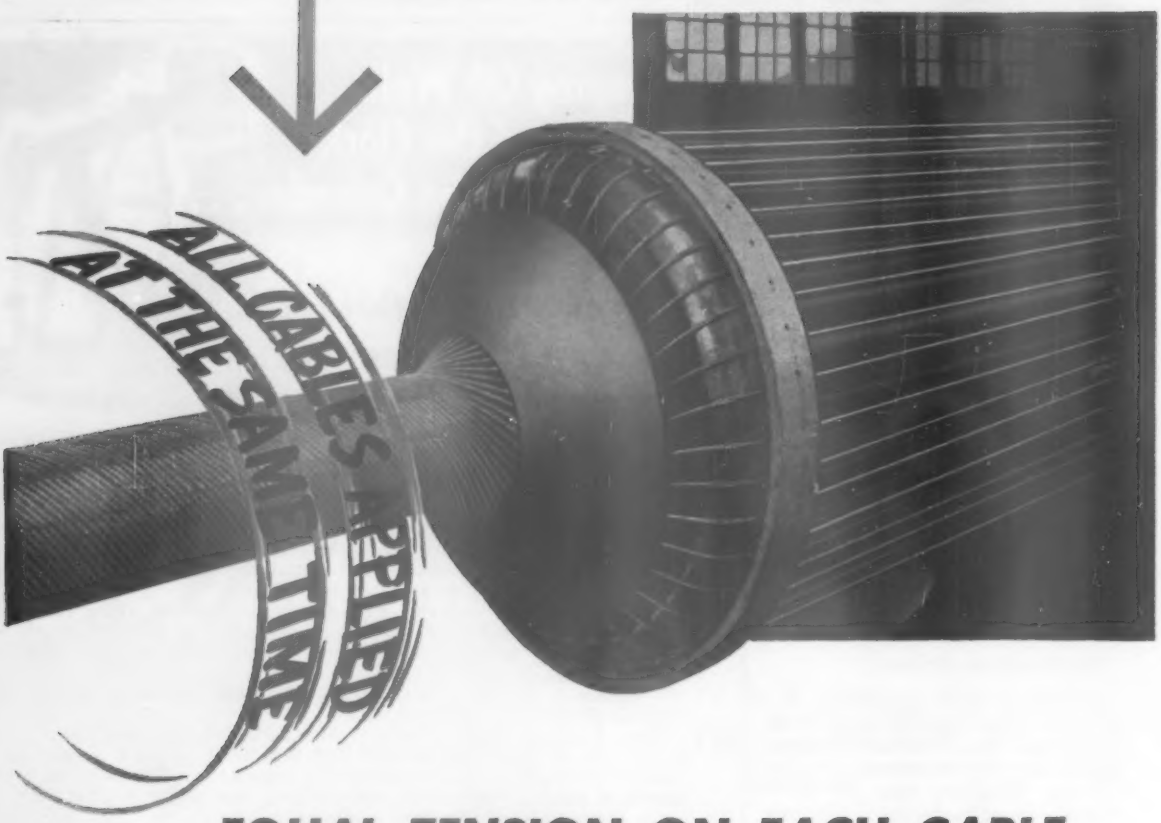

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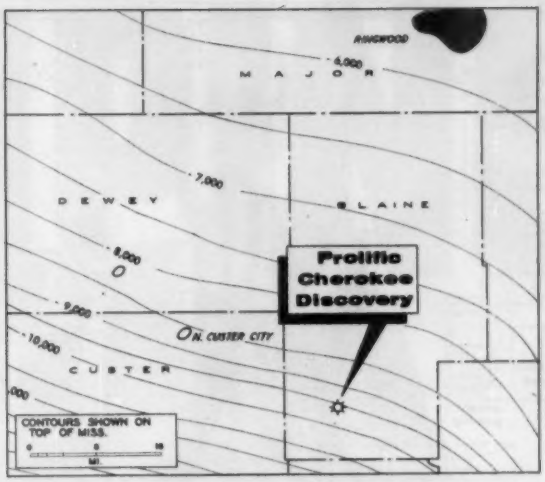
Drilling action brisk in western Oklahoma

Panhandle well sets possible record

A POSSIBLE flow record for Tonkawa Pensylvanian wells was set in the Oklahoma Panhandle last week at the east offset to newly opened South Plainview field in Beaver County.

Sun Oil Co. 1 Manse Wood, SW NE 36-1n-24eCM, 8 miles southeast of Elmwood near the Texas line, was potentialed flowing 39 M.M.c.f.d. plus 7 bbl. of condensate in 4 hours on ⅞-in. choke. Production is at 6,007-14 ft. in the Tonkawa.

This well is the east offset to the field discovery well, Sun 1 Caleb Harper. That strike was a Tonkawa oil discovery.



BLAINE COUNTY'S third gas field opened last week at Sunray Mid-Continent Oil Co. 1 Baker in C SE SE 36-14n-13w. This remote discovery flowed 2,430 M.c.f.d. on 4-hour test through 10/64-in. choke and 68½ bbl. condensate per million; on 5-hour test at 13/64-in. choke the gas was 3,530 M.c.f.d. with no condensate gaged; it flowed 4,570 M.c.f.d. on 3-hour test on ¼-in. choke and 62 bbl. condensate per million. A two-point open flow test made 41 M.M.c.f.d.

Pennsylvanian pay for Oklahoma's Beaver

Remote Des Moines Pennsylvanian production is reported in Oklahoma's Beaver County. Sinclair Oil & Gas Co. 1 W. E. Overton in C NE SW 13-3n-23eCM, 8 miles northwest of Elmwood in the Oklahoma Panhandle, flowed up to 4,640 M.c.f.d. with oil spray on test at 6,316-6,440 ft.

Location of this gas prospect is 20 miles northeast of Des Moines oil at South Boyd field.

New Oklahoma finds

In Oklahoma, Sinclair Oil & Gas Co. has indicated discoveries in Ellis and Beaver counties.

Sinclair's 1 W. E. Overton unit, in C NE SW 13-3n-23eCM, in Beaver County, flowed 4,640 M.c.f.d. on a 3-hour drill-stem test of the Oswego at 6,316-6,440 ft. Recovery netted 840 ft. of free 44°-gravity oil.

The indicated strike is 6 miles south of the town of Beaver, 2 miles south of nearest production, and 15 miles southeast of nearest Oswego production in Floris pool.

In Ellis County, Sinclair's 1 Anson J. Woods, in C SW NE 2-23n-26w, at the town of Catesby, flowed gas at the daily rate of 9,972 M.c.f. through a ¾-in. choke from fractured Morrow-sand perforations at 8,332-35 and 8,339-57 ft. Testing continues. The well is located 2 miles southwest of Catesby field.

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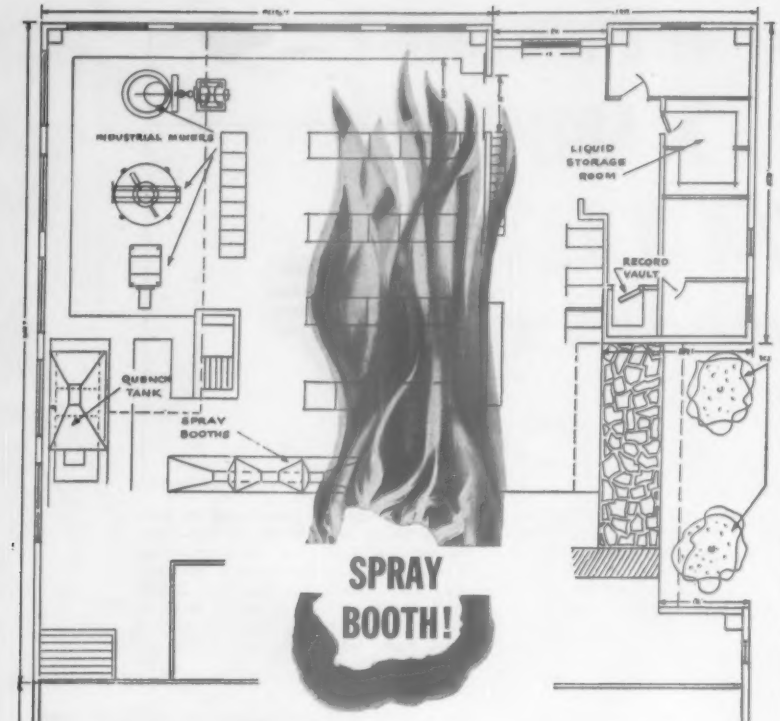

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ALBERTA'S newest Foothills belt gas discovery is at Burnt Timber, 55 miles northwest of Calgary.

Foothills gets fifteenth gasser

THE fifteenth gas-producing area along the Foothills belt of Alberta's Canadian Rockies was opened last week at Shell Oil Co. of Canada, Ltd.'s Burnt Timber wildcat, 27 miles west of Elkton oil field. The new discovery flowed 2 M.M.c.f.d. from a 100-ft. interval in Mississippian below 11,205 ft.

Burnt River 6-22-31-9 is 10½ miles northeast of Shell's Panther River field, a Mississippian and Devonian producing area. Location is on LSD 6, 22-31-9w5. Drilling continues below 11,380 ft.

Burnt River is another link in the chain of deep gas reservoirs being tapped along the mountain front from Lookout Butte on the U. S. border northwestward toward British Columbia.

N.B. well slated

NEW BRUNSWICK is the site of a fourth exploratory well for Imperial Oil, Ltd. The new well will be known as the Imperial-New Brunswick Oilfields 1 Port Elgin, and will be located about a mile north of the town of Port Elgin.

The company's third exploratory well in New Brunswick, Imperial-New Brunswick Oilfields 1 Pollet River, has been abandoned as a dry hole after being drilled to a depth of 6,756 ft.

These new wells are part of Imperial's current exploration program in the Maritimes, which began in 1956 after a geological survey crew was sent to Cape Breton Island. Surveys were extended to Prince Edward Island in 1957, and exploratory drilling was begun in P.E.I. in 1958. The rig was moved into New Brunswick early in 1959.

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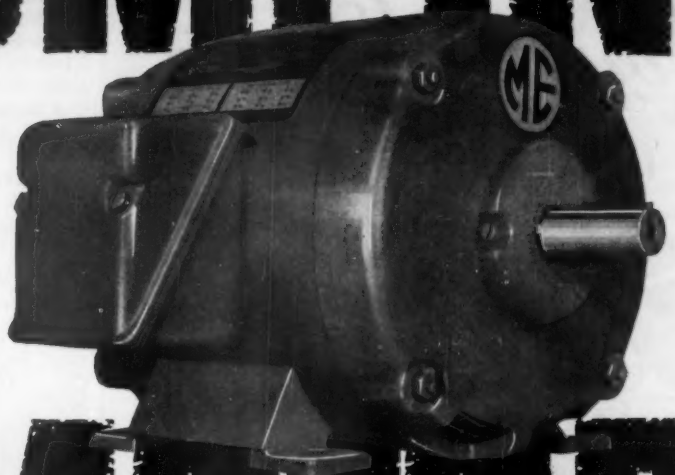

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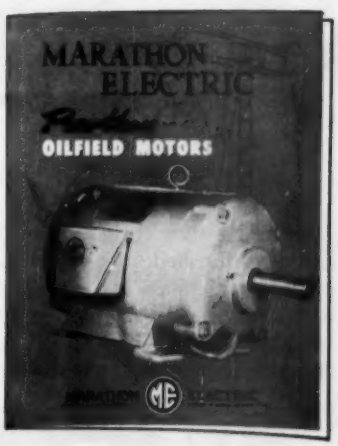

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Drillers active in Illinois, Indiana

Both Indiana and Illinois figured highly in Illinois basin developments.

In White County Illinois two new pays were opened in the area 4 miles southeast of Enfield. Inland Producers and J. D. Turner 1 Ruth Simmons, NW NW SW 25-5s-8e, flowed 18 bbl. of oil hourly from O'Hara lime at 3,146-61 ft. and Rosiclare lime at 3,190-95 ft.

A southwest offset discovery, H. N. Sanders 1 Charles Britton, SE NE SE 26-5s-8e, is testing Cypress sand at 2,783-2,811 ft. Recovery was 1,560 ft. of clean oil, and 90 ft. oil-mixed mud. Another well in the area, H. N. Sanders 1 Wilson, a ½-mile outpost, flowed 31 bbl. per hour in the Aux Vases at 3,126-36 ft. This one is in NW NE NE 23-5s-8e.

In Hamilton County, Illinois, 6 miles west of Norris City, Calvin Oil Co. 1 Hunt-Benefiel Unit, NW SE NW 21-6s-7e, pumped 300 bbl. per day from Aux Vases sand at 3,072-90 ft. This is a ½-mile stepout hit.

Indiana . . . In Warrick County, Don P. Monroney and J. C. Westfall, Jr. 1 Russell O. Tennyson, SW NW NE 22-5s-7w, was completed for 28 bbl. per day from Cypress sand on pump at 1,224-46 ft. This discovery is 4 miles east of Boonville and 5 miles from production.

In Spencer County, Hart & Hart 1 John and Alma Long, NW NE NW 36-5s-6w, 2 miles north of Chrisney, got 400 ft. of oil in 6 hours, natural, on test of the Aux Vases lime at 1,171-77 ft.

In Perry County, Indiana, Milt Yunker & Associates et al. 1 Jones, SE SE NW 26-4s-3w, 1 mile east of Bristow, swabbed 10 bbl. of oil per hour, natural, from Jackson sand at 252-259 ft. Well is on pump. The 2 Jones, a south offset, is drilling at 325 ft. in Jackson after getting ½ bbl. of oil per hour.

In Gibson County, Indiana, Elbo Co. has two new wells on the C. W. Wheaton lease 2 miles southwest of Somerville in 15-3s-9w. The No. 1 well in NW NW SE, area discovery, made 86 bbl. per day from Hardinsburg sand at 1,281-95 ft. and the 2 well, a south offset, made 58 bbl. per day at 1,301-09 ft.

In Illinois . . . Three new pay strikes are reported in an area 4 miles southeast of Enfield in White County. Inland Producers and J. D. Turner 1 Simmons, NW NW SW 25-5s-8e, found production in the Benoist at 2,955-72 ft., the O'Hara lime at

3,146-61 ft., and the Rosiclare lime at 3,190-95 ft.

In Jefferson County, 5 miles northeast of Mount Vernon, F. L. Strickland 1 Johnson, SW SW SW 6-2s-4e, was completed on pump for 114 bbl. of oil daily, natural, from McClosky lime at 2,880-87 ft.

Texaco, Inc. is busy at a deep wildcat in Wayne County, the 3 I. Cravens NCT-1, NE SW NW 33-2s-7e. It made 265 bbl. of oil daily from Warsaw 4,152-64 ft. on choke.

Southwest Kansas keeps fast drilling tempo

The march into the new Council Grove Permian pay in southwestern Kansas continues strong. A deep inside Hugoton test in Kearny County is shut in for production tests. It is Northern Natural Gas Co. 1-27 Broadhurst, Area 11, C NE SW 27-26s-37w, 9 miles south of Hartland and 13 miles from nearest Council Grove gas. The well flowed 3,190 M.c.f.d. on tests. Top of Council Grove is 2,696 ft.

In northeastern Stevens County, 4½ miles northwest of West Center Council Grove field, Hugoton Production Co. 2-23 Larrabee, C SE 23-31s-39w, flowed 5 M.M.c.f.d. on tests. Gas flowed from several sets of perforations in the Council Grove.

Louisiana dry hole is now producer

A wildcat reported abandoned last December as a dry hole at 6,807 ft. is being converted into an oil-discovery well for Concordia Parish, eastern Louisiana.

The well, E. C. Wentworth and others 1 Sturgeon, is 1¾ miles northwest of Monterey, and 1¾ miles southeast of Lismore Landing field.

Hole was cleaned out to 5,742 ft., where casing was run and cemented, and then perforated opposite Wilcox sand at 5,643½-45½ ft.

Initial production, flowing through 9/64-in. choke, was 90 bbl. daily with pressure of 350 psi.

Louisiana's Choudrant adds second pay zone

Choudrant field, in southeastern Lincoln Parish, North Louisiana, previously productive from the Jurassic - Cotton Valley horizon, has added the slightly shallower Hosston (Lower Cretaceous) formation for its second pay zone.

Both zones are productive of gas and condensate. The Hosston discovery well is California Co.'s 1 Edmiston 2, which flowed at the rate of 3 M.M.c.f. of gas and 22 bbl. of 57°-gravity condensate per day through 14/64-in. choke.

Hole, drilled to 10,463 ft., is perforated at 8,568-79 ft.

A previous test of the Cotton Valley, perforated at 10,278-90 ft. and 10,377-401 ft., flowed 145 M.c.f. of gas, 4 bbl. of condensate, and 40 bbl. of water per day through 20/64-in. choke. Bottom is plugged back through this horizon to 8,688 ft.

New Michigan prospects look good

MICHIGAN'S best looking new oil prospect since January this year is on the same Trenton-Black River dolomite trend that has boomed development the past several months.

McClure, Covey & Null 1 Van Wert, SE SE SE 8-6s-2w, Adams Township, Hillsdale County, 4½ miles southeast of Scipio field, on drill-stems showed pay from 3,921 to 4,000 ft., where well was cased and cemented. On drill-stem from 3,949-

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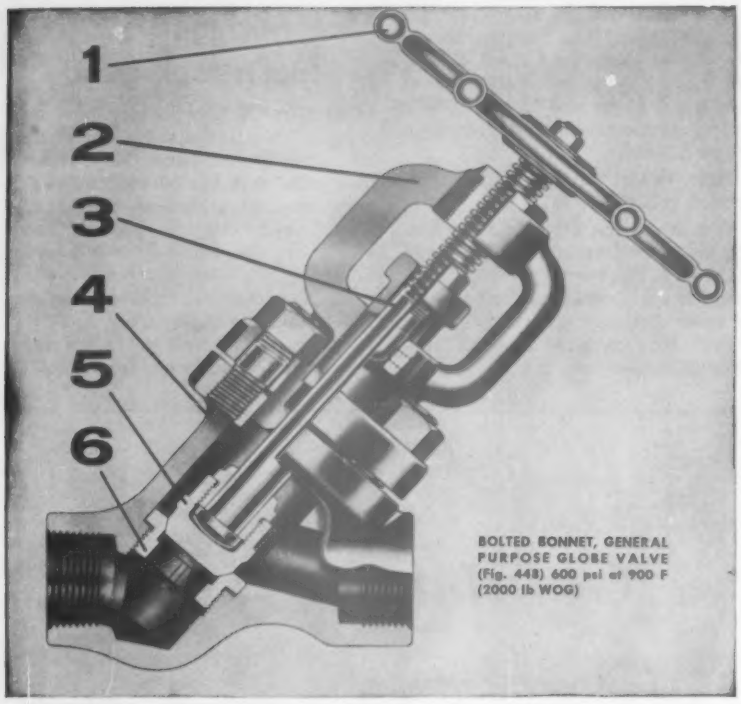

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UNION BONNET, INSIDE SCREW GLOBE VALVE (Fig. 2698) 600 psi at 900 F (2000 lb WOG)

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4,000 well had gas to surface in 3 minutes and oil in 26 minutes. It flowed 50 bbl. clean oil to tanks in 61 minutes, with initial flow pressure of 338 and final of 418 lb., and shut-in pressure of 1,560 lb.

The location is on a "ruler line" with Scipio, Pulaski, and Albion, now proving up production (but not connected as yet) over 24 miles on a southeast line.

Aurora Oil & Gas Co., Ohio Oil Co., and McClure control the bulk of the acreage in the area of the new strike.

Geologically, the wildcat confirmed projections by some geologists that the Trenton southeast of Scipio would lose its porosity-pay characteristics dominant in the other fields to the northwest. The Van Wert well drilled an entire lime section in the Trenton and showed neither gas nor oil. Pay is in the Black River. Trenton logged at 3,466 and Black River at 3,818. First dolomite was logged at 3,845 ft. A few isolated wells in both the Pulaski and Scipio fields are producing from the Black River, but in these instances the Trenton had carried either gas or oil to some degree.

The Hanover play 7 miles due east of Pulaski field, viewed 6 weeks ago as a new parallel Trenton trend play, has all but died after heavy spending and the drilling of three Trenton tests besides the discovery.

Bell and Gault 1 Bissell, SE SW NE 8-4s-2w, is shut down for orders at 4,343 ft., 518 ft. in the Trenton and 350 ft. in the Black River. The wildcat gaged up to 17 M.m.c.f. gas while drilling Trenton but failed to log oil. None of the other three tests drilled in the area carried either gas or oil.

Three permits have been approved for the Albion townsite area at the northwest end of the proven field to mark the first drilling inside the city limits. Earlier production was established at both the west and south sides of the city limits.

Success continues in Ohio's Ashtabula

CONTINUED successes mount in the Clinton gas play in Ashtabula County in northeastern Ohio as three additional tests were reported complete.

The largest gasser of the area and largest reported this year, Felmont Oil Corp. 1 Walter Hall, Section 17, Monroe Township, had a flow of 20,500 M.c.f. after fracture from the pay at 3,085-3,105 ft. Also, in the same township, Biller & Flanagan 1 J. & H. Tackacs, Section 5, had 1,375 M.c.f. after fracture at 3,189-3,246 ft.

In Sheffield Township, Belden & Blake completed their 1 T. & W. Gilbert, Section 14. The sand was reported at 3,097-3,115 ft. and had a flow of 1,500 M.c.f. after fracture.

● In the general area in Dorset Township, a basement test by Devonian Gas & Oil Corp. 1 C. Mueller, Section 2, is still drilling at 5,750 ft.

● Brendel Oil Co. reported completion of a western stepout to a gas pool in southwest Falls Township, Muskingum County.

The Clinton pay on Hugh White, 3 Qr., Williams Survey, was logged at 3,535-51 ft. and flowed 125 bbl. of oil per day 2 days after fracture.

New Morrow find for Sooner's Ellis

Another Morrow Pennsylvanian gas pool was tapped in northwestern Oklahoma's Ellis County. The new producer, just at the edge of Catesby town, is Sinclair Oil & Gas Co. 1 Woods in C SW NE 2-23n-26w.

This new producer flowed 10,450 M.c.f.d. through 1-in. choke after treatment with 20 bbl. condensate and 164-bbl. load of water per day. Perforations are at 8,332-35 and 8,339-57 ft. The well is separated from Northeast Catesby field itself by a dry hole. There is both Morrow oil and gas production in that field.

East Texas action sets quick pace

East Texas developments include a deep wildcat for Leon County, a confirmation to Lavelle field in Houston County, more news on the newest salt-dome discovery, and oil recovery at a deep Van Zandt County wildcat.

● Deep exploration will take a Leon County wildcat down to about 12,500 ft. for a test through Travis Peak. Humble Oil & Refining Co. will drill the 1 L. J. Craig in the south-central part of the county on the E. Ewing Survey. The well is about 5 miles southeast of production at McBee field, a Rodessa and Travis Peak producer of gas.

● Humble completed its 1 B. N. Curry as a confirmation to the discovery well of Lavelle field in eastern Houston County. Calculated open flow was 26,500 M.c.f.d. plus 17 bbl. condensate per million. Perforations are at 7,829-36 ft. in Woodbine. This confirmation success is 5 miles southwest of Kennard and is on the Blake Carleton Survey. It is ¾ mile southeast of Harris Fender 1 Houston County Timber Co., G. Gonzales Survey, the discovery well. That well made 23 M.M.c.f.d. plus 25 bbl. con-

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densate per million from Woodbine at 7,837-39 ft.

• The Woodbine is being perforated at East Texas' newest salt-dome discovery prospect, Whiffen Estate, Inc. 1 Daniel Memorial Orphanage on the Butler Salt Dome in southeastern Freestone County. The new prospect is 2 miles southeast of Butler on the Simon Sanchez Survey, A-30. This prospective salt-dome strike is on the flank of the dome where four dry holes were drilled last year. The operator will perforate and test a 12-ft. section in the Woodbine where logs indicated production.

• In Van Zandt County, R. J. Caraway is drilling below 8,427 ft. at the 1 W. A. McCoy, a 13,000-ft. Smackover wildcat ¾ mile southeast of Fruitvale in the northern part of the county. Recovery on test of the Rodessa was 1,875 ft. of oil at 8,279-8,303 ft. Location is on the James Cheshire Survey, A-181.

Texans slate meeting

The second annual regional meeting of the SFGS-AAPG will take place in Lubbock, October 8-10.

Keynoter will be Dr. John Lonsdale, head of the Texas Bureau of Economic Geology, whose talk "Permian Basin, Now and Then," will kick off a 17-paper technical program.

In addition to experts from surrounding states a thousand oil men are expected to attend from Southwest member societies in Texas.

Texas' Motley well shows free gas

Gas is reported on test of a Palo Duro basin wildcat in Motley County, Texas. General Crude Oil Co. 1-A Ollie Echols Birnie, Section 9, Block GP, C&M Survey, 10 miles northwest of Matador and 2 miles southwest of the recent Pan American Petroleum Corp. discovery at 1 Birnie which got gas in the Strawn, got free gas during test at 8,750-95 ft. Successful completion of this indicated hit would further enhance this basin's production hopes. A considerable number of wildcats have been drilled throughout the area this year.

Texas wildcat completed

A remote shallow wildcat test in far-southwestern Texas' sparsely explored Val Verde County has been completed as a small oil-discovery well.

It is Askmore & Ewell and others' 3 Massie West, 5 miles northwest of Juno. Completion is on the pump making 14 bbl. of 17.8°-gravity oil

daily from Lower Cretaceous-Paluxy sand at 360-74 ft.

Nearest other field, one of few in the county, is more than 20 miles northeast at Rehders where two small shallow pumpers have been completed. The latter also produce from the shallow Paluxy sand.

Good gas flow reported at gulf well

Gas flow rated good for 320 M.M.c.f.d. has been tested in a newly completed well in Chesterfield field, in southeastern Colorado County, Texas Gulf Coast.

The well is Cerro De Pasco Corp.'s 2 Oswald G. Wolf, in Wolf & Becker Survey No. 30, 5 miles east of Eagle Lake. Its pay zone, at 9,023-25 ft., is in a new Wilcox sand opened last June by the same operator's initial, but much smaller, well on the lease.

Gas carries an ungaged volume of 57.9° - gravity condensate. Shut - in pressure is 2,398 psi.

Wilcox extended in Southwest Texas field

Wilcox production at San Miguel Creek in northern McMullen County, Southwest Texas, is being extended a mile northeast.

The extension well, Humble Oil & Refining Co. 1-D Louis Gubbels, also opens a slightly deeper reservoir in the Wilcox. It is perforated at 6,132-38 ft. Other productive Wilcox zones are above 6,000 ft.

Completion is on the pump, making 35 bbl. of 38.2°-gravity oil daily.

San Miguel Creek, discovered in 1948, also has one deep Edwards gas well with pay at 10,150 ft.

Dual discovery for New Mexico well

A DUAL WILDCAT oil and gas discovery is reported in San Juan County, about 2½ miles south of Farmington, N. M. The new well, brought in by Tennessee Gas & Oil Co., is in the San Juan basin about 10 miles north of Gallup production.

The 8 U.S.A.-Glen Callow, SW SE 27-29n-13w, inside Blanco field, found gas and condensate in the Dakota Cretaceous sandstone at 5,764-5,887 ft. and oil in the shallower Gallup Cretaceous formation.

During a potential test of the Gallup, oil flowed at a rate of 505 bbl. per day on a ½-in. choke. The Dakota tested 5,640 M.c.f.d. and 313 bbl. of condensate per day on a ¾-in. choke.

Wyoming's Fremont has new gas find

The north flank of the Wind River basin is the site of a new gas discovery by Gulf Oil Corp. Flow of gas was gaged at 6,012 M.c.f.d. on drillstem test at 1 Lysite-Federal, SW NE 23-39n-91w, Lysite area, Fremont County, Wyoming.

Tool was open an hour from 6,781-6,823 ft. Sample top of Fort Union Tertiary at 4,409 ft. is the only top reported. Formation tested is not identified. Flowing pressure reached 3,260 psi. and 30-minute shut-in pressure was 3,460 psi.

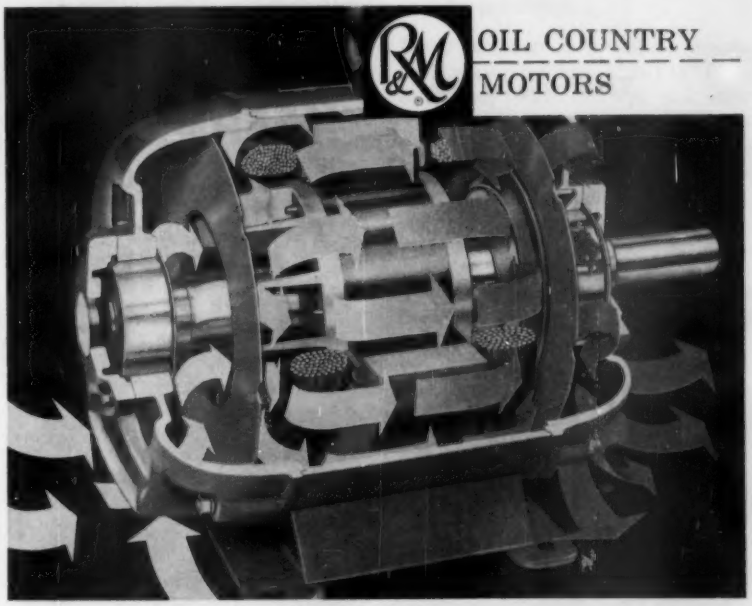
Gulf is drilling at 6,831 ft. and has not indicated the projected total depth. The new well is located in a highly complex area 4 miles northeast of production at West Lysite and about 6 miles northwest of Lost Cabin field.

Discovery wells

ARIZONA

Apache County: Texas Pacific Coal & Oil Co. 1 Navajo-138, C NE NE 11-40n-28e. IPP 240 BOPD, plus 27 BWPD, Mississippian discovery, new field. TD 6,080 ft. Precambrian.

Superior Oil Co. 2 Navajo "H," SW SW 16-41n-30e. IPF 4,002 M.c.f.d., 23/64-in. choke, Hermosa discovery, new gas field. TD 6-787 ft. Precambrian.



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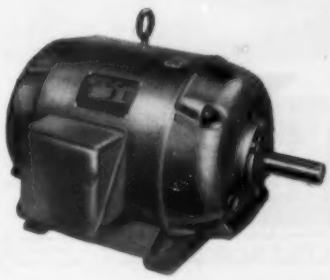

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ARKANSAS

Miller County: Smith & Cameron and H. Emery Galbraith 1 Rader Endsley et al. 10-19s-27w, 2½ miles west of Doddridge. IPP 140 BOPD and 25 BWPD, 36°, perf. 6,149½-56½ ft., Lower Anhydrite stringer sand. TD 7,213 ft. Discovery well West Doddridge field.

CALIFORNIA

Ventura County: Standard Oil Co. of California 1 Standard-General Petroleum-Arundell, NW SE 19-4n-19w, no production details released, TD. 14,711 ft. (Extension test ¾ mile northeasterly of Spaulding production in Fillmore field).

Ventura County: Standard Oil Co. of California 1 Daily, SW SW 12-1n-22w, no production details released, perfs. 6,747-6,824 ft., Td 11,217 ft. (Successful extension test ½ mile southeast of production in the Oxnard field).

WESTERN CANADA

Alberta: Lobitos 10-22-51-8 Bigoray, LSD 10, 22-51-8w5. Indicated Cardium oil discovery. TD 6,150 ft.

Woods Petroleum 6-2-37-1 Mintlaw, LSD 6, 2-37-1w5. Indicated Mississippian gas discovery. TD 9,145 ft.

British Columbia: Pacific-Sunray-Imperial A-61L Sojer, 61-L-94-H-4. Baldonnal gas discovery. TD 5-227 ft.

Saskatchewan: Thunderbird 2-17 Pinto, LSD 2, 17-2-4w2. Midale oil discovery. TD 4,444 ft.

COLORADO

Rio Blanco County: Beardmore Drilling Co. 30-1 Government, C NE NE 30-2s-102w. IPF 4,877 M.c.f.d., Mancos discovery, new field. TD 2,666 ft. Mancos.

Washington County: Plains Exploration Co. 1 Jesse, C SE SW 22-2n-54w. IPF 1,403 M.c.f.d., "D" sand discovery, new field. TD 4,915 ft. "J" sand.

NORTHWEST NEW MEXICO

San Juan County: Benson-Montin and Greer Drilling Co. 1 Greer, SW NW 2-26n-11w. IPF 237 BOPD, Gallup discovery, new field. TD 6,567 ft. Dakota.

SOUTHEAST NEW MEXICO

Lea County: William A. and Edward R. Hudson 1 Matlock, 4-20s-34e, 4¼ miles southwest of Pearl field. IPP 60 BOPD, 30°, Seven Rivers, open hole, top pay 3,615 ft. TD 3,630 ft. New oil discovery.

OHIO

Medina County: E. J. McBride 1 M. H. Henning, Section 12, Westfield Twp. IPF 3,600 M.c.f.d., Clinton sand 3,078-93 ft. Rock pressure 1,050 psi. TD 3,170 ft.

NORTH TEXAS

Jack County: Leatherwood Drilling Co. 1 Webb, southeast part of county, 3 miles northeast of Perring Ranch field, 4 miles northeast of Perrin on J. F. Middleton Sur., A-2125. IPP 131 BOPD, plus 60 bbl. water, 43°, Caddo conglomerate 4,501-04 ft. TD 5,525 ft. New oil discovery.

SOUTHWEST TEXAS

Starr County: Sun Oil Co. 1 Reilly Gas Unit, Porcion 97, 15 miles southeast of Rio Grande City. AOF 670 M.c.f.d., GLR 110 M.c.f. per barrel, 60.1°, perf. 4,635-45 ft., Vicksburg. TD 4,710 ft. New field.

Nueces County: Puenticita Oil Co. 58-B Simmonds & Perry, Section 8, Simmonds & Perry Subd. of Elliff Tract, 5 miles southwest of Banquete. IP 162 BOPD, 10/64-in., 33.8°, GOR 285 cu. ft. per bbl. TP 740 psi., perf. 7,374-76 ft., and shut-in gas well, no gage, perf. 7,222-24 ft. TD 7,900 ft. New pay in Brayton field.

TEXAS PANHANDLE

Ochiltree County: Shamrock Oil & Gas Corp. 1 Sam Danshues et al. Ses. 741, Blk. 43, H&TC Sur., 8 miles southeast of Perryton, east-central part of county, 2½ miles south of Ellis Ranch Cleveland Marmaton and Morrow field, 2½ miles north of Northrup Douglas field. IPCAOF 5,100 M.c.f.d., Cleveland 7,084-7,108 ft. TD 9,210 ft. Gas discovery.

Ochiltree County: Shamrock Oil & Gas Corp. 1 C. H. Kelln, Sec. 919, Blk. 43, H&TC Sur., 6½ miles southeast of Perryton. IPP 102 BOPD, 39.6°, Morrow 8,064-79 ft. TD 8,630 ft. New oil discovery.

WEST CENTRAL TEXAS

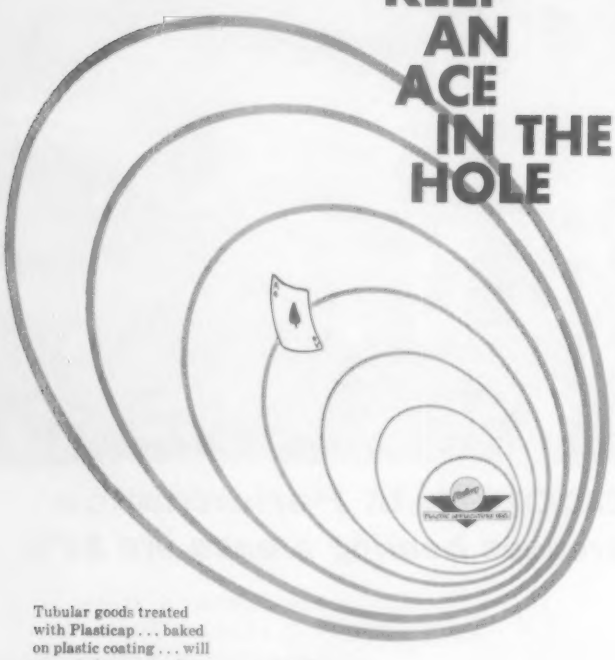
Palo Pinto County: Fryer & Hanson Drilling Co. 1-E Stuart, Sec. 54, Blk. 3, T&P Sur., 14 miles northwest of Strawn. IP 11 BOPD, ¼-in. choke, 46°, GOR 72,500:1, Strawn 1,630-35 ft. TD 1,665 ft. Shut-in TP 272 psi.

Texas Pacific Coal & Oil Co. 2-A Allen G. Stuart, Sec. 84, Blk. 4, T&P Sur., 5 miles northwest of Strawn. IP 129 BOPD, 48/64-in. choke, 41°, GOR 1,500:1, TP 40 psi., pay 3,527 ft. TD 3,538 ft.

Parker County: Christie, Mitchell & Mitchell 1 R. T. Lans, Sec. 31, T&P Sur.,

Throw away the joker . . .

KEEP AN ACE IN THE HOLE



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A-1424, 4 miles southeast of Springtown. IP 3 M.M.c.f.d., open 2-in. tubing, TP 1,620 psi., conglomerate 5,210-20 ft. TD 6,820 ft., PB 5,340 ft. Recompletion.

Stephens County: Edwards & Herring 1 S. R. Hill, Sec. 16, SPRR Sur., A-2680, 3 miles south of Eliasville. IP 49 BOPD, 20/64-in. coke, 43°, GOR 44,000:1, TP 1,510 psi., conglomerate 4,093-98 ft. TD 4,125 ft.

Taylor County: Gly, Inc., 1 West Texas Utilities Co., Sec. 60, BAL Sur., 2 miles southeast of Abilene. IP 51.3 BOPD, 6/16-in. choke, 40.8°, GOR 75:1, TP 40 psi., Flippen lime 1,808-31 ft. TD 1,867 ft.

Throckmorton County: Dwight M. Ross Drilling Co. 1 Sam R. Davis, B. Garner Sur., A-202, 5 miles east of Throckmorton. IP 240 BOPD, 12/64-in. choke, 40°, GOR 800:1, TP 300 psi., Marble Falls 4,650-70 ft. TD 4,707 ft.

WEST TEXAS

Andrews County: Ralph Lowe 1 A. M. Morgan Est., 31 miles west of Andrews, Sec. 11, Blk. A-50, PSL Sur., 4 miles southeast of Nelson field, 4 miles northwest of Blk. 12 field. IPP 231 BOPD, 31.8°, Wichita Albany 7,931-43 ft., 7,946-55 ft., 7,963-73 ft., 7,987-97 ft. TD 11,490 ft. New oil discovery.

Crockett County: R. E. Sutton et al. 1 Halff, 6½ miles southeast of Iraan in northwest part of county, Sec. 63, Blk. 1, I&GN Sur. IPF 156 BOPD, Queen sand 1,350-62 ft., 1,365-73 ft., and 1,378-81 ft., 23/64-in. choke, 33.5°. TP 176 psi. TD 1,509 ft. New oil discovery.

Kent County: Bill Roden et al. 1 Girard Trust, 14 miles south of Spur, Sec. 35, Blk. 1, H&GN Sur. IPF 168 BOPD, lower Pennsylvanian 6,574-80 ft., 6,586-96 ft., 16/64-in. choke, 32°, TP 200 psi. TD 6,695 ft. New oil discovery.

Pecos County: Sinclair Oil & Gas Co. 2 Iowa Trust "B," Sec. 17, Blk. 10, H&GN Sur., 11 miles southwest of Imperial. IP 130.3 BOPD, 32/64-in. choke, 39°, GOR 4,650:1, TP 80 psi., Devonian 5,792-98, 5,805-14 ft. TD 6,169 ft., ground elevation 2,475 ft.

Reagan County: Cabot Carbon Co. 1 Zulette Hughes, 3 miles east of Stiles, Sec. 5, Blk. L., TCRR Sur., 1¾ miles northeast of Stiles field. IPF 182 BOPD, 23/64-in. choke, 59.3°, GOR 3090:1, Open hole 10,420-462 ft. Ellenburger. TD 10,462 ft. Ellenburger oil discovery.

Reeves County: Gulf Oil Corp. 1-CL TXL, NCT-A, 16 miles northwest of Pecos, Sec. 1, Blk. 54, T-4, T&P Sur., 7 miles northwest of North Pecos field. IPF 8 BOPD, plus 93% water, 15/64-in. choke, 30.5°, Delaware 4,231-37 ft., TD 4,303 ft. New oil discovery.

Shell Oil Co. 1-L University, 11 miles south of Andrews, Sec. 34, Blk. 1, Univ. Lds. Sur., 3½ miles northwest of Midland Farms field. IPF 266 BOPD, 16/64-in. choke, 42.6°, Devonian 9,860-70 ft. TD 11,500 ft. New oil discovery.

Upton County: J. C. Williamson and Empire Drilling Co. 1 Bell, south-central part of county, 10 miles northwest of Rankin, Sec. 2, E. J. Lilleton Sur. IPF 374 BOPD, 16/64-in. choke, 42.8°, Strawn 9,744-56 and 9,776-82 ft. TD 10,200 ft. New oil discovery.

WYOMING

Weston County: Stuarco Oil Co. 1 David Cellers, C NE NE 7-44n-66w. IPF 130 BOPD, Newcastle discovery, new pay. TD 6,978 ft.

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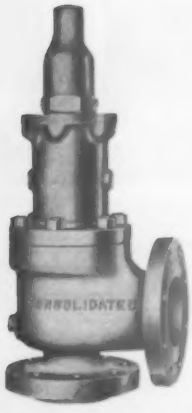

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J. Howard Marshall
. . . Signal's new executive vice president.

Signal's Marshall Knows Oil

. . . from one end to the other. His career includes law, government, as well as all phases of the oil industry.

AN INTEGRATED man for an integrated oil company.

That just about characterizes J. Howard Marshall's association with Signal Oil & Gas Co.

Marshall, recently elevated to the post of executive vice president, has an extensive background in all phases of the business which make up an integrated company.

He has helped plan, build, and operate substantial refining and pipeline companies, including service as president of Ashland Oil & Refining Co. and its subsidiaries from 1944 to 1951. During that same period, he served as vice president of the American Petroleum Institute's Division of Marketing.

As special counsel for Standard Oil Co. of California in the mid-1930's, he was active in Standard's crude-oil purchasing, producing, and leasing operations in California. A good deal of this work involved negotiating with Signal.

Meanwhile, in the past couple of years, Signal has experienced a tremendous growth from a California independent producer to an important producer in domestic and foreign fields with substantial refining and marketing interests.

Marshall's present position with Signal, which he joined as a director in 1952, is a natural.

In California, industry people joke about whether Signal is now the state's largest independent or smallest major. With more than $500 million in assets, Signal certainly deserves consideration in either category.

Marshall thinks the independent tag is still appropriate.

"When you start operating by the committee system, then you're a major. We still operate through individual executive responsibility, so I imagine that makes us still an independent," Marshall explains.

Signal's future . . . As to Signal's future plans, Marshall sees the current trend of steady, almost spectacular, expansion continuing. He says:

"As far as the recent acquisition of Eastern States Petroleum & Chemical Corp. is concerned, we look forward, naturally, to some day being able to market the output from the 60,000-bbl. Houston refinery more through direct outlets than is now the case. However, all that is down the road a ways. It will be a gradual process.

"In California, we are looking at plans for substantial expansion of the refining facilities of both Hancock and Bankline Oil Co., which Signal also recently acquired. Initially, we expect to use as much equipment and process units as practicable from the fire-damaged Hancock refinery to build up the Bankline plant at Bakersfield."

Signal eventually expects to develop refining facilities in the Los Angeles Basin or elsewhere on the West Coast.

"Just where is still up in the air," Marshall adds, "but we'll probably start from the grass roots with this phase of our refinery expansion plans."

"One factor which will influence our decision on refining in California is the fact that we have a very large quantity of 20°-gravity crude production. If you try to sell it as crude, chances are you will sell it for its fuel oil content. However, with fuel oil surpluses in California, we feel it is probably more advantageous to design our own process units to get the maximum light ends from this rather heavy crude production," Marshall said.

No stranger . . . Marshall's acquaintance with Signal operations dates back as far as 1935 when he was with Standard of California.

In addition, without realizing it at the time, Marshall was associated with an operation as far back as 1927 which would eventually lead back to Signal. After graduating from Haverford College in 1926, Marshall worked a couple of years as cruise director on the unique Floating University. This was a project where a group of college students chartered an ocean liner in 1926 and 1927 and sailed around the world, holding classes enroute.

In 1927, the Floating University used Dollar Line ships for its campus. Eventually, the Dollar Line became the American President Lines. Several years ago, Signal acquired with others a controlling interest in the American President Lines.

Varied career . . . In addition to his oil-industry experience, Marshall has had distinguished careers in government and law.

He graduated from Yale University's Law School with honors in 1931. He stayed on there a couple years, serving as assistant dean of the law school and as professor of law. His private legal practice included service as a partner in the top West Coast law firm of Pillsbury, Madison and Sutro in San Francisco from 1938 to 1944.

His government service has included membership on Petroleum Administration Board, Department of Interior, from 1933 to 1935. During that time, he also served as special assistant to the United States Attorney General and assistant solicitor in the Department of Interior.

From 1941 to 1944, he was chief counsel and assistant deputy adminis-

▶▶▶ Personals

trator of the Petroleum Administration for War. In 1945, he was general counsel to the U. S. delegation to the Allied Commission on Reparations. His most recent government service was as consultant to the Secretary of Interior on the petroleum defense program.

Currently, he is serving as a member of the Military Petroleum Advisory Board to the Joint Chiefs of Staff.

In addition to his position with Signal, Marshall is a director or officer of eight other oil industry companies. These include Wyoming Nebraska Pipe Line Co., Great Northern Oil Purchasing Co., Frontier Refining Co., Kingwood Oil Co., Minnesota Pipe Line Co., Great Northern Oil Co., American Independent Oil Co., and the South Saskatchewan Pipe Line Co.

He is also a member of the API, National Petroleum Council, AIME, American and California Bar Associations, Twenty-Five Year Club of the Petroleum Industry, Bohemian Club, Beta Rho Sigma (Haverford) and the Order of Coif (Yale).

●

Ken Davis, Jr., president of Kendavis Industries, Inc., International, will become president of Loffland Brothers, domestic companies. He succeeds **R. W. Wire,** who resigned earlier this month as president of the drilling firm. Davis is also chairman of the board of Unit Rig & Equipment Co. and is a former executive vice president of Great Western Drilling Co., another Kendavis Industries company.

Lee Flood, formerly senior associate with Bart De Laat & Associates, Houston consulting firm, has joined Fred Whitaker, Carthage, Tex., independent, as manager of operations. Flood had been with De Laat & Associates since 1954. He was with Cities Service Oil Co., the Goldsmith Pool Engineering Committee, and did independent consulting work before that time. Flood will headquarter in Carthage.

Cleo J. Gracey, geologist with Gulf Oil Corp., has resigned to open consulting offices in Houston. Gracey had been with Gulf 23 years. He is a graduate of the University of Houston.

Sir Henry Jones, deputy chairman of the British Gas Council, will succeed **Sir Harold Smith** as chairman on January 1. **W. K. Hutchison,** chairman of the South Eastern Gas Board, will become the council's new deputy chairman.

M. R. McArthur, executive vice president of Husky Oil Co., has been elected president of Rimrock Tidelands, Inc., Husky subsidiary. McArthur succeeds **Earl Bateman,** of Bateman Drilling Co., who will continue as a Rimrock director. McArthur will headquarter in New Orleans.

H. R. Rohwedder becomes assistant director of operations and **J. G. Barnhart** assumes duties as assistant general superintendent of compressor stations in changes announced by Natural Gas Pipeline Co. of America and Texas Illinois Gas Pipeline Co., affiliates.

T. W. Barron, superintendent of the Jumping Pound, Alta., gasoline plant of Shell Oil Co. of Canada, has been named superintendent of Shell Oil's Notrees, Tex., TXL gasoline plant. He succeeds **M. L. Newmaster,** who was recently transferred to Shell's New York gas department as senior gas engineer in the gas utilization group.

George K. Spradling has been appointed supervisor of planning and scheduling in the maintenance and construction department of Tidewater Oil Co.'s Avon refinery, Associated, Calif. Spradling will be succeeded as engineering coordinator, planning, scheduling, and estimating, in the Avon engineering department by **Charles G. Moore. Ernest F. Ehmke, Jr.,** has been appointed engineering coordinator, corrosion, in the engineering department.

Douglas P. Bates, head of the chemical products department at Esso Standard Oil Co.'s Bayway refinery, Linden, N. J., has been promoted to operations superintendent at Bayway. He succeeds **W. J. Sheridan,** who was recently named manager of Everett, Mass., refinery. **Harry Taylor,** head of the petroleum products department at Bayway, has been appointed chemical products head, succeeding Bates. **Fred A. Westphal,** head of the mechanical department, will succeed Taylor. **Al Sitarski,** former head of the maintenance division, succeeds Westphal. **Jack Grady,** head of the construction division, will be head of the combined maintenance and construction divisions.

John C. Johnston has been appointed manager of exploration for Pan American Petroleum Corp. He will headquarter in Tulsa. Johnston has been Texas-Louisiana Gulf Coast division exploration superintendent for Pan Am in Houston for the past year. A graduate of the University of Wyoming, he joined the company in 1940. Since that time he has held posts as Jackson, Miss., district geologist, Rocky Mountain division geologist, and Rocky Mountain division exploration superintendent before the Houston assignment.

JOHNSTON

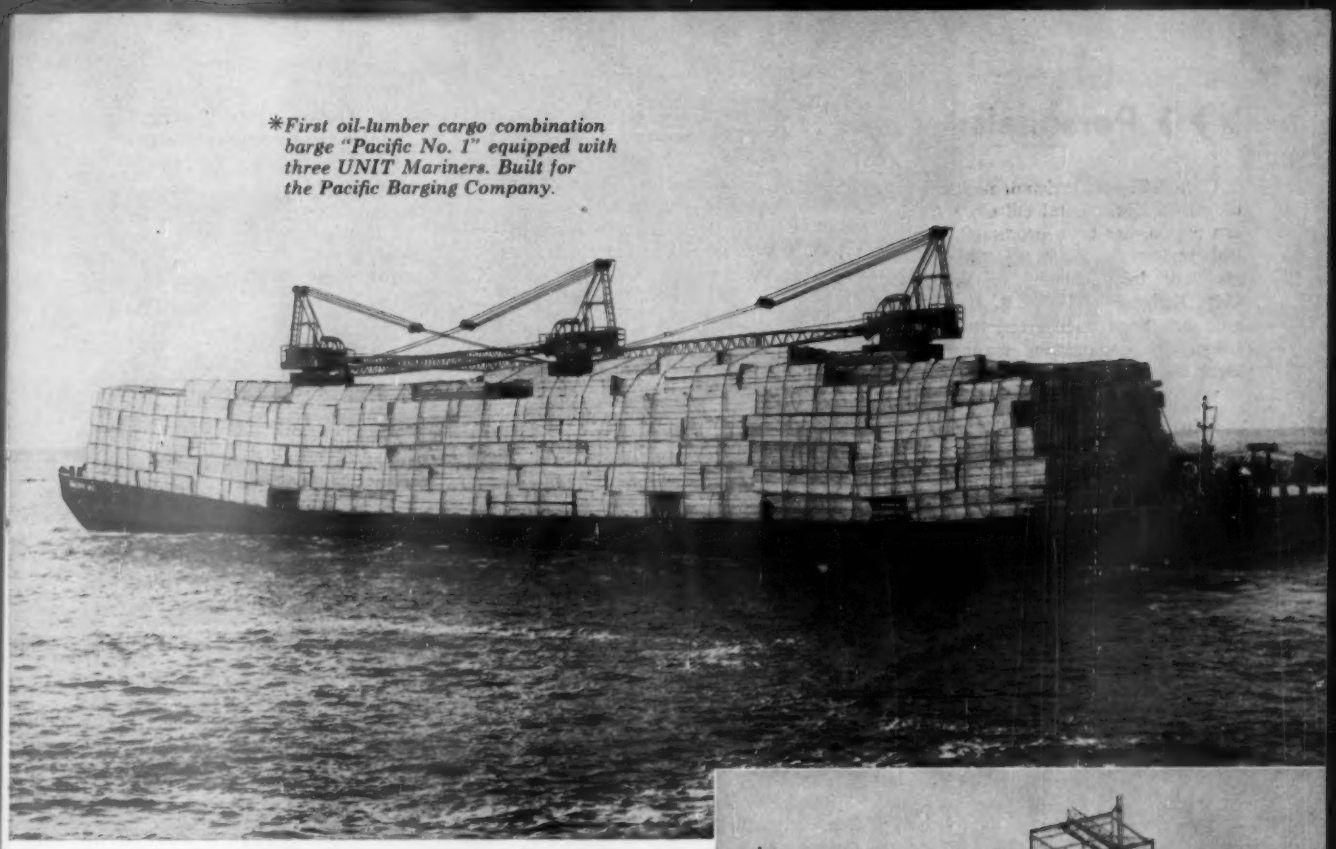
Charles A. Dawson has been transferred by Skelly Oil Co. from Shreveport, La., to Bismarck, N. D., where he will be district manager. Dawson succeeds **W. R. Strickland,** who recently resigned to become an independent operator in Bismarck.

Calvin Cooksey has been transferred from Carter Oil Co.'s Denver office to Salt Lake City where he will head a new district office. **A. T. Gibbon,** formerly in Durango, Colo., will succeed Cooksey as Denver district geologist.

C. H. Fay, manager of the physics and mechanics department, basic research, for Shell Development Co. in Houston, has been named technical assistant to the president. He will headquarter in New York. Fay joined Shell Oil Co. in 1941 and moved to Shell Development in 1953.

Estill S. Heyser, Jr., of Heyser & Heard, Dallas, is newly elected president of Texas Mid-Continent Oil and Gas Association. Heyser has been vice president of the general Mid-Continent Oil and Gas Association for the past 2 years. He succeeds **Charles W. Alcorn,** Houston, vice president of Falcon Seaboard Drilling Co. as president of the Texas group. New district vice presidents are **Marvin L. McCullough,** Wichita Falls, North Texas; **H. E. Dishman,** Beaumont, Upper Gulf Coast; **Alvin C. Hope,** San Antonio, Southwest Texas; and **C. E. Yager,** Fort Worth, North Central Texas.

HEYSER



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Personals

C. S. Killgore, assistant regional geologist in Continental Oil Co.'s southern region, has been promoted to central region manager of exploration. He will headquarter in Oklahoma City. Killgore succeeds **B. B. Colley,** who has been transferred to Tripoli, Libya, as exploration manager for Oasis Oil Co., an affiliate.

Edwin P. Davis, formerly land coordinator in Dallas for British-American Oil Producing Co., has joined McElroy Ranch Co. in Fort Worth as manager of exploration. He will supervise and coordinate exploration departments in the company's Midland and Denver division offices.

John A. Warder, vice president of Cia. Shell de Venezuela, is now president of the company. He succeeded **G. C. K. Dunsterville,** whose retirement was announced earlier this year. Warder joined Asiatic Petroleum Co., Ltd., in London in 1927. He held assignments in Argentina and Cuba before World War II. He later served in The Hague and in New York. In 1950 he became president and general manager of Cia. Mexicana Petroleo "El Auila," S.A. and in 1953 became general manager in Colombia. He had been vice president of Shell de Venezuela since 1957.

WARDER

Frank B. Markle, Wayne V. Jones, and **Daniel B. Lovejoy,** vice presidents of Union Oil & Gas Corp. of Louisiana, have been promoted to senior vice presidents. In other top management changes, **Maxwell L. Euwer,** vice president, has been named general manager of production, and **Elliott H. Powers,** vice president, has been named general manager of domestic exploration. Also, **William H. Woods,** vice president of Runnels Gas Products Corp., subsidiary, has been appointed general manager of Union's gas department. **Claude C. Harris, Jr.** assistant to the vice president and treasurer, becomes controller. **Donald K. Hawes,** secretary and assistant treasurer, has been named secretary and treasurer. **Russell A. Peterson** has been appointed assistant secretary and assistant treasurer. **Elliott G. Flowers** has been named coordinator of government relations.

H. L. Mendenhall, technical assistant to the chief geophysicist of Phillips Petroleum Co., has been promoted to assistant chief geophysicist in the land and geophysical department, Bartlesville, Okla. He succeeds **C. D. Hier,** who was recently transferred to the international department as chief geophysicist for Australian operations.

F. H. Rhees, vice president and a director of Sinclair Oil & Gas Co., has been promoted to operations coordinator, a new position. Rhees has been with Sinclair since 1925. He is also a director of Sinclair Canada Oil Co., a subsidiary. In the new assignment he will coordinate production, gas and gas products, liquefied gas products sales, engineering, property acquisition, part interest, motor transportation, and mechanical maintenance. He will continue as vice president and a director.

Gilbert F. Moore, formerly on special assignment for Pan American Petroleum Corp. as assistant to the division manager in Houston, has been appointed manager of gas sales, a new position (see related story on p. 101). Moore also becomes president of Pan American Gas Co., a subsidiary. Headquarters of the subsidiary have been moved to Tulsa from Houston. Operating offices will remain in Texas City. Other officers of Pan American Gas are **R. L. Marek,** Tulsa, and **E. A. Renfro,** Houston, vice presidents; **K. R. Goldsmith,** Tulsa, secretary; **F. J. Keleher,** Tulsa, treasurer; **A. W. Bounds,** Houston, assistant secretary; and **A. J. Greenway,** Houston, assistant treasurer.

MOORE

Deaths

Frank W. Reese, 93, retired superintendent of Humble Pipe Line Co.'s southern division, died September 14 at his home in Houston. Reese retired in 1933 after 14 years with Humble. He was the company's oldest annuitant.

Edgar F. Harrell, 66, retired budget director of Reed Roller Bit Co., died September 14 in a Houston hospital. Harrell was with the old Deepwater Oil Co., Texas Petroleum Co., and Navarro Oil Co. before joining Reed Roller Bit in 1946. He retired last year.

Don S. Scott, Billings, Mont., district sales manager for Husky Hi-Power, Inc., and **Don Bennett,** construction superintendent at the company's Cody, Wyo., refinery, were drowned September 12 in a boating accident at Hayden Lake, Idaho.

Robert Jarvin, Graham, Tex., retired driller for Fain & McGaha, died September 9.

Cicero I. Murray, 70, Lindsay, Okla., attorney who directed shutdown of Oklahoma production during the 1930's "hot oil" controversy, died September 14 in Lindsay. Murray was a distant cousin of the late Oklahoma governor William H. (Alfalfa Bill) Murray.

S. L. Thornley, 82, Allegan, Mich., independent operator, died September 6.

L. W. Brummitt, 66, Kalamazoo, Mich., retired secretary-treasurer of Lakeside Refining Co., died September 7.

Capt. H. R. Adams, retired marine manager for Sinclair Refining Co., died September 6 in Upper Darby, Pa. Adams joined Sinclair in 1921. He was appointed marine manager in 1951 and retired last year.

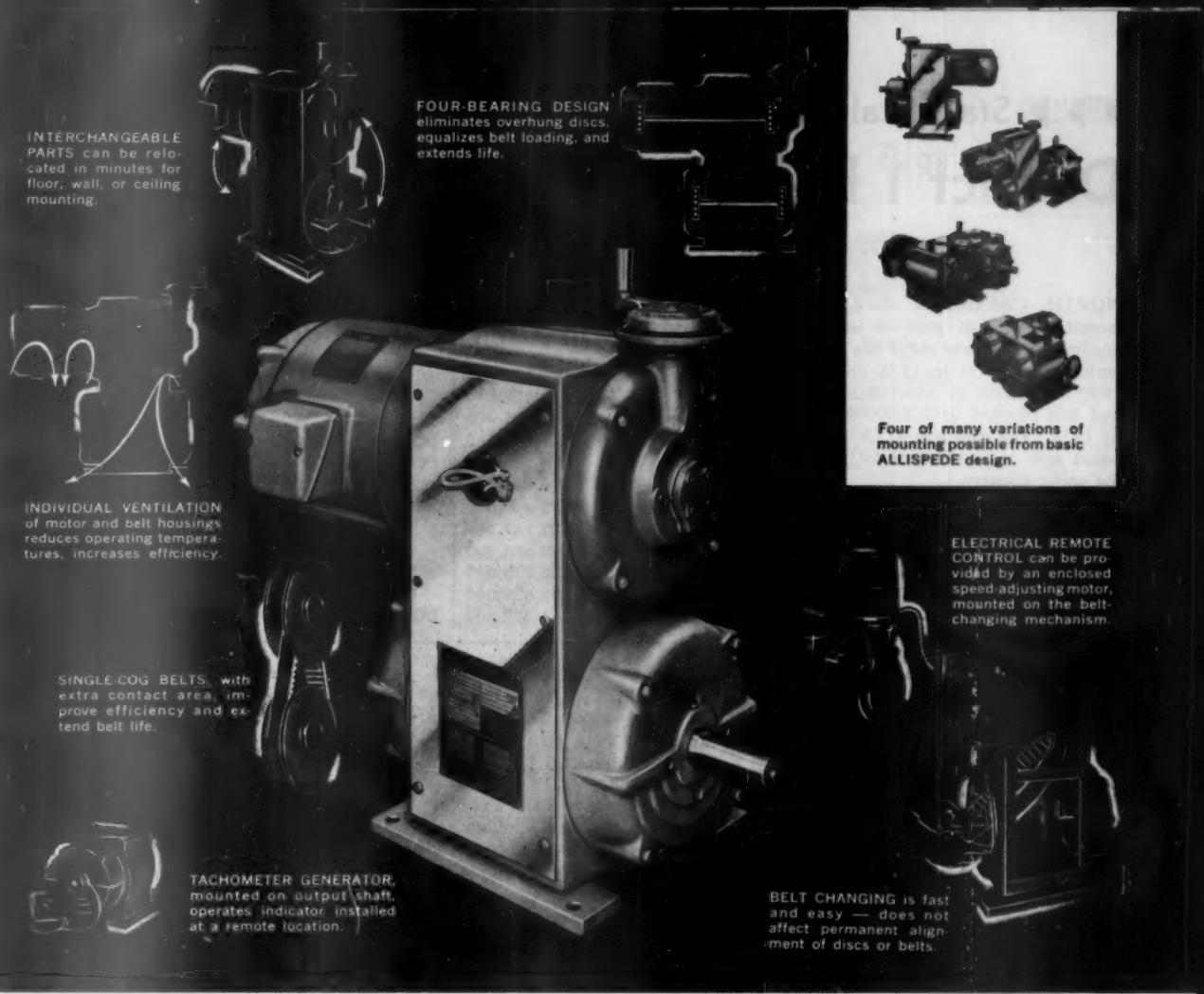
Paul F. Sullivan, 46, Tulsa oil lease buyer and formerly tool pusher and drilling foreman, died September 13 in Chattanooga, Tenn., after a heart attack.

William M. Holmes, 48, assistant manager of Humble Oil & Refining Co.'s employe relations department, died September 11. Holmes had been with Humble since 1933. He was regional employe relations manager at Tyler, Tex., before moving to Houston in 1957.

Clint Leon Marvin, 86, retired rig builder, died recently at his home in Arcadia, Calif., after a brief illness.

John Hiram Bankston, 81, retired Tulsa oil man, died September 14 in a Tulsa hospital. Bankston was at one time operator of Arkoma Oil Co. with his son, the late John H. Bankston.

Andrew Turnbull Jergins, 86, retired president of Jergins Oil Co., died September 15 at his home in San Antonio, Tex.


INTERCHANGEABLE PARTS can be relocated in minutes for floor, wall, or ceiling mounting.
FOUR-BEARING DESIGN eliminates overhung discs, equalizes belt loading, and extends life.
Four of many variations of mounting possible from basic ALLISPEDE design.
INDIVIDUAL VENTILATION of motor and belt housings reduces operating temperatures, increases efficiency.
ELECTRICAL REMOTE CONTROL can be provided by an enclosed speed-adjusting motor, mounted on the belt-changing mechanism.
SINGLE-COG BELTS, with extra contact area, improve efficiency and extend belt life.
TACHOMETER GENERATOR, mounted on output shaft, operates indicator installed at a remote location.
BELT CHANGING is fast and easy — does not affect permanent alignment of discs or belts.

Let's look at the features of the ALLISPEDE* Drive

New Louis Allis drive offers accurate control—maximum belt life—long-run economy—low-cost versatility—ease of installation

Here's a drive so easily adaptable to changing physical and operating needs that it obsoletes obsolescence. You can relocate components — add or remove attachments and controls — in the field, in minutes.

Its *all-new* design improves performance and efficiency. Inspection, servicing, and belt-changing are a snap. Furthermore, maintenance is almost nil.

As for versatility — there's an Allispede to meet whatever mechanical drive requirement you have. Sizes up to 30 hp, output speeds from 1 to 10,000 rpm, and speed ranges up to 8:1. Motors can be open, drip-proof, enclosed, or explosion-proof—with ventilated or enclosed belt housings — for foot, P-base, C- or D-flange mounting on your machine.

Allispede is available with parallel shaft, or right-angle, integral speed reducers; special shaft extensions; integral magnetic brakes; electrical or mechanical remote control, and other modifications.

Interested? Contact your nearby Louis Allis District Office or write to The Louis Allis Co., 449 East Stewart Street, Milwaukee 1, Wisconsin, for a copy of Bulletin 3600.

*Allispede is a trademark of The Louis Allis Company.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

AED-133

District 1 heating-oil sales jump 15%

BY JOHN C. CASPER

NORTH CAROLINA showed the largest percentage gain in sales of heating distillate and range oils for the period from 1950 to 1958. Sales in 1950 amounted to 246,700,000 gal. and had climbed to 779,000,000 gal. by 1958. The gain was 215.8% compared with an increase of 59.0% for the entire country.

Better than 63% of all range and heating oils was sold in District 1 last year. These records are taken from the latest report of fuel oil and kerosine sales by the Bureau of Mines.

The table, compiled from data in the bureau's reports, shows sales of range oil and distillate heating oil for years 1958, 1957, and 1950. Note that the largest percentage gain by a district for the 1950-58 period was the 67% increase in District 1. The volumetric gain by this district was almost 8 billion gallons.

District 2 sales represented about half the volumetric gain reported for District 1 but the percentage increase was 65%.

A quick look at the highlights . . .

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	6,831,490	UP	24,370,000	DOWN	2,300,985
Crude stocks	251,948,000	DOWN	1,405,000	UP	8,640,000
Completions	983	DOWN	8	UP	21
Refinery runs	8,181,000	UP	49,000	UP	336,000
Gasoline stocks	183,491,000	UP	1,982,000	UP	10,600,000
Kerosine stocks	32,787,000	UP	1,433,000	UP	3,139,000
Distillate stocks	168,578,000	UP	5,380,000	UP	22,388,000
Residual stocks	58,778,000	UP	1,271,000	DOWN	9,600,000
Four-product stocks	443,634,000	UP	10,066,000	UP	26,527,000
Total imports	1,673,500	DOWN	33,900	UP	397,000

Sales of range and heating distillates in Districts 3 and 5 were lower in 1958 than in 1950. Texas was the only state to show a gain in District 3, and Washington had the lone increase in District 5.

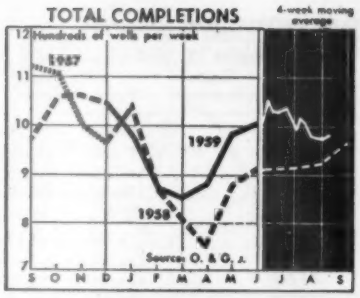
Customers in the State of New York bought better than 3 billion gallons of heating distillate and range oil last year to lead the nation in sales. There were six other states with sales above a billion gallons. Four were in District 1, and the other two in District 2.

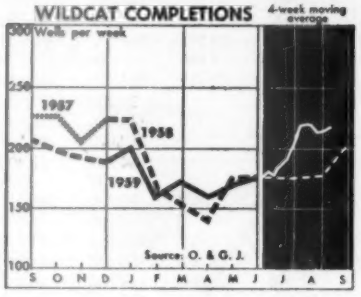
The report shows that availability of natural gas has had a definite influence on sales of heating oils. The influence may grow in producing states with increased pressure for intrastate sales of natural gas.

Sales of Range Oil and Distillate for Heating

(Thousands of gallons)

	1958	1957	1950	% inc. 1958 over 1950
District 1	**13,338,696**	**11,553,024**	**7,982,184**	**67.1**
Connecticut	1,066,422	806,022	583,086	82.9
Delaware	124,446	134,736	70,266	77.1
Dist. of Col.	133,014	148,428	94,248	41.1
Florida	227,094	182,700	112,434	102.0
Georgia	126,630	132,174	105,840	19.6
Maine	340,452	340,326	244,902	39.0
Maryland	650,286	662,760	356,622	82.3
Massachusetts	2,199,876	1,745,226	1,320,354	66.6
New Hampshire	219,702	250,488	168,630	30.3
New Jersey	1,570,548	1,451,688	1,129,716	39.0
New York	3,153,486	2,655,030	2,052,498	53.6
North Carolina	779,016	592,284	246,666	215.8
Pennsylvania	1,473,276	1,351,980	790,524	86.4
Rhode Island	370,272	292,278	262,332	41.1
South Carolina	277,116	231,504	112,560	146.2
Vermont	147,882	88,494	70,644	109.3
Virginia	461,790	456,792	242,802	90.2
West Virginia	17,388	30,114	18,060	—3.7
District 2	**6,438,222**	**5,899,740**	**3,910,578**	**64.6**
Illinois	1,472,730	1,108,212	815,094	80.7
Indiana	759,150	519,960	302,316	151.1
Iowa	357,672	403,368	285,138	25.4
Kansas	66,360	107,016	60,270	10.1
Kentucky	91,056	103,866	48,804	86.6
Michigan	1,123,080	1,036,014	580,146	93.6
Minnesota	527,898	645,666	484,512	9.0
Missouri	406,434	332,514	255,192	59.3
Nebraska	112,266	153,048	115,542	—2.8
North Dakota	87,570	118,146	66,738	31.2
Ohio	543,438	486,150	307,020	77.0
Oklahoma	17,766	43,596	46,242	—61.6
South Dakota	92,988	107,184	71,148	30.7
Tennessee	68,208	97,104	85,470	20.2
Wisconsin	711,606	637,896	386,946	83.9
District 3	**267,162**	**335,076**	**304,500**	**—12.3**
Alabama	39,690	56,826	44,688	—11.2
Arkansas	10,416	39,648	45,444	—77.1
Louisiana	37,128	51,996	42,924	—13.5
Mississippi	13,986	31,290	23,814	—41.3
New Mexico	10,836	14,154	11,634	—6.9
Texas	155,106	141,162	135,996	14.1
District 4	**209,328**	**280,140**	**157,794**	**32.7**
Colorado	36,162	59,178	38,430	—5.9
Idaho	91,182	87,822	44,604	104.4
Montana	30,366	53,844	36,960	—17.8
Utah	37,842	52,206	23,730	59.5
Wyoming	13,776	27,090	14,070	—2.1
District 5	**828,996**	**945,168**	**900,522**	**—7.9**
Arizona	12,180	10,080	19,320	—37.0
California	135,912	148,554	219,618	—38.1
Nevada	19,110	20,790	22,764	—16.1
Oregon	211,638	244,650	226,254	—6.5
Washington	450,156	521,094	412,566	9.1
Total U. S.	**21,082,404**	**19,013,148**	**13,255,578**	**59.0**





Active Rotary Rigs

	9-14-59	9-7-59	9-15-58
Alabama	9	9	5
Arkansas	21	18	23
Arizona	2	2	2
California	102	106	75
Land	97	100	(*)
Offshore	5	6	(*)
Colorado	52	55	35
Florida	1	1	1
Land	1	1	1
Offshore	0	0	0
Illinois	39	48	62
Indiana	11	9	6
Iowa	2	2	3
Kansas	130	135	156
Kentucky	8	8	8
Louisiana	320	326	310
North	35	34	38
S. Inland waters	129	125	(†)
S. Land	106	105	235
Offshore	50	62	37
Maryland	0	0	0
Michigan	34	30	10
Mississippi	70	70	46
Missouri	0	0	1
Montana	29	31	20
Nebraska	25	31	25
Nevada	2	2	0
New Mexico	120	122	95
New York	0	0	2
North Dakota	21	19	32
Ohio	5	3	1
Oklahoma	218	220	223
Oregon	0	0	0
Pennsylvania	11	8	9
South Dakota	7	6	3
Texas	722	745	681
S. Inland waters	6	5	(†)
S. Land	187	196	141
Offshore	0	2	1
North-East	164	176	(*)
West Central	237	241	(*)
West	128	125	(*)
Utah	32	31	31
Washington	2	2	0
West Virginia	5	5	2
Wyoming	88	88	69
Total U. S.	2,088	2,132	1,936
Western Canada	157	150	153
Eastern Canada	1	1	4
Grand total	2,246	2,283	2,093

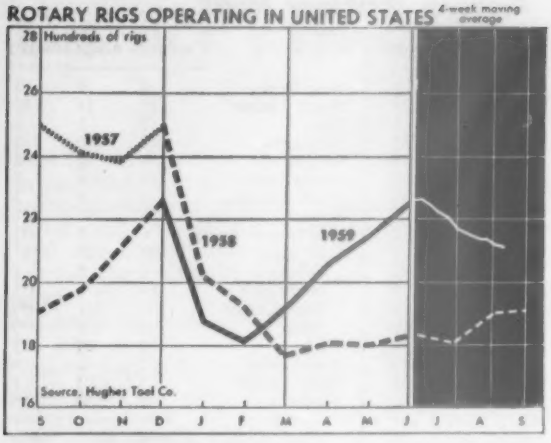
Hughes Tool Co. report. *Comparisons not available due to change in method of reporting. †Included in South-Land.

WEEKLY WELL COMPLETIONS . . . WEEK ENDED SEPTEMBER 12, 1959

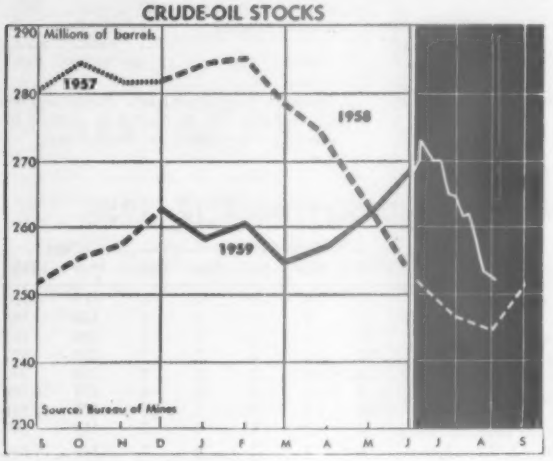
	Total wells							Cum.		Total wildcats					Cum	
	Total	Crude	Cond.	Gas	Dry	Service	Footage	1959	1958	Total	Crude	Cond.	Gas	Dry	1959	1958
Alabama	0	0	0	0	0	0	0	65	51	0	0	0	0	0	17	20
Arkansas	13	7	0	1	5	0	45,426	578	522	3	0	0	0	3	100	114
California	23	9	0	2	10	2	101,782	1,050	1,119	10	2	0	1	7	266	263
Colorado	15	3	0	4	8	0	71,388	544	561	10	1	0	2	7	325	327
Illinois	38	11	0	0	27	0	82,493	1,569	1,494	8	0	0	0	8	270	302
Indiana	17	6	0	0	11	0	26,602	576	522	5	1	0	0	4	195	186
Kansas	92	42	0	2	46	2	364,127	2,807	2,620	30	4	0	1	25	679	556
Kentucky	43	17	0	13	13	0	54,249	1,686	803	8	1	0	0	7	169	101
Louisiana	69	38	5	2	24	0	508,784	2,575	2,391	9	1	1	0	7	346	347
North	29	18	0	2	9	0	79,986	985	864	3	1	0	0	2	148	142
South	34	16	4	0	14	0	370,923	1,318	1,211	5	0	1	0	4	184	185
Offshore	6	4	1	0	1	0	57,875	272	316	1	0	0	0	1	14	20
Michigan	23	9	0	2	12	0	76,216	448	291	8	0	0	1	7	115	96
Mississippi	14	3	1	0	10	0	122,349	434	269	8	0	0	0	8	199	123
Montana	9	5	0	0	4	0	47,892	226	232	3	0	0	0	3	71	96
Nebraska	21	8	0	0	13	0	127,841	618	494	6	0	0	0	6	259	230
New Mexico	59	38	2	7	12	0	254,009	1,438	1,369	5	1	0	0	4	168	185
West	27	15	2	6	4	0	99,429	654	659	1	1	0	0	0	45	76
East	32	23	0	1	8	0	154,580	784	710	4	0	0	0	4	123	109
New York	0	0	0	0	0	0	0	195	391	0	0	0	0	0	18	37
North Dakota	5	2	0	0	3	0	32,939	340	326	3	0	0	0	3	65	106
Ohio	31	9	0	11	8	3	87,835	690	742	2	0	0	1	1	23	12
Oklahoma	92	44	0	11	37	0	413,274	4,010	4,457	21	1	0	3	17	608	611
Pennsylvania	0	0	0	0	0	0	0	335	438	0	0	0	0	0	9	14
Texas	358	194	17	23	115	9	1,641,739	13,296	12,562	74	6	2	1	65	2,509	2,560
Dist. 1	10	5	0	0	0	5	17,341	769	674	4	0	0	0	4	221	270
Dist. 2	18	4	2	3	9	0	114,357	558	528	7	0	0	0	7	168	139
Dist. 3	22	6	1	0	15	0	155,201	846	909	8	0	0	0	8	173	202
Dist. 4	32	14	8	4	6	0	190,624	939	838	6	2	1	0	3	231	246
East	18	4	3	0	11	0	83,889	860	854	8	0	0	0	8	168	236
Dist. 7-B	46	19	0	1	25	1	149,680	1,818	1,710	14	1	0	1	12	486	483
West	114	84	0	4	26	0	603,315	4,082	3,622	14	0	0	0	14	564	506
Dist. 9	65	40	0	1	21	3	193,549	2,501	2,527	11	3	0	0	8	423	404
Dist. 10	33	18	3	10	2	0	133,783	923	900	2	0	1	0	1	75	74
Utah	10	8	0	1	1	0	55,976	221	276	1	0	0	0	1	58	59
West Virginia	17	2	0	13	1	1	37,618	539	502	1	0	0	1	0	20	12
Wyoming	24	6	1	0	13	4	116,633	692	516	9	0	0	0	9	236	153
Misc. (S.D., N.C.)	10	0	0	0	10	0	24,496	98	67	10	0	0	0	10	65	57
Total U. S.	983	461	26	92	383	21	4,293,668	35,030	33,015	234	18	3	11	202	6,790	6,567
Previous week,	991	454	29	70	415	23	4,161,600	.....	.....	227	21	2	10	194	.....	.....
Cum. 1959	35,030	17,617	857	2,564	13,092	900	145,755,775	.....	.....	6,790	641	89	217	5,843	.....	.....
Cum. 1958	33,015	16,186	806	2,529	12,643	851	136,969,046	.....	.....	6,567	638	113	191	5,626	.....	.....
Western Canada	30	20	0	7	3	0	176,813	1,719	1,717	4	1	0	1	2	482	464
Ontario	0	0	0	0	0	0	0	154	.....	.....	.....	.....	.....	.....	.....	.....

PRODUCTION

ROTARY RIGS OPERATING IN UNITED STATES



CRUDE-OIL STOCKS



CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

	9-5-59	8-29-59	9-6-58
Pennsylvania	2,732	2,692	2,887
Other Appalachian	1,980	2,085	1,408
Illinois, Indiana, Michigan	9,620	9,632	10,806
Nebraska and North Dakota	2,471	2,715	1,971
Kansas	9,867	10,066	9,033
Oklahoma	15,312	16,000	16,077
Arkansas	2,218	2,175	1,912
Louisiana	18,666	18,748	15,871
North	3,366	3,396	2,685
South	15,300	15,352	13,186
Mississippi, Alabama, Florida	2,467	2,563	2,539
New Mexico	8,203	7,741	8,092
Texas	106,817	107,751	99,769
East Texas	8,476	8,515	7,856
West Texas	49,739	50,570	49,062
Texas Gulf	18,537	18,953	17,867
Other Texas	30,065	29,713	24,984
Wyoming	16,122	15,444	13,445
Other Rocky Mountain	9,767	10,212	9,041
California	30,720	31,149	35,952
Foreign	†14,986	14,380	14,505
Total	251,948	253,353	243,308

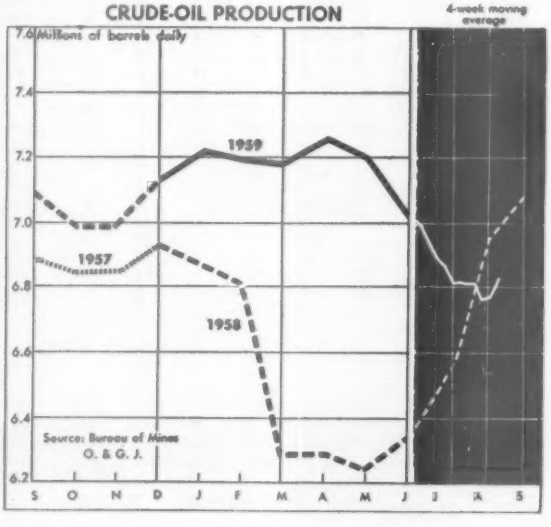
*Bureau of Mines. †Includes 4,494,000 bbl. in California.

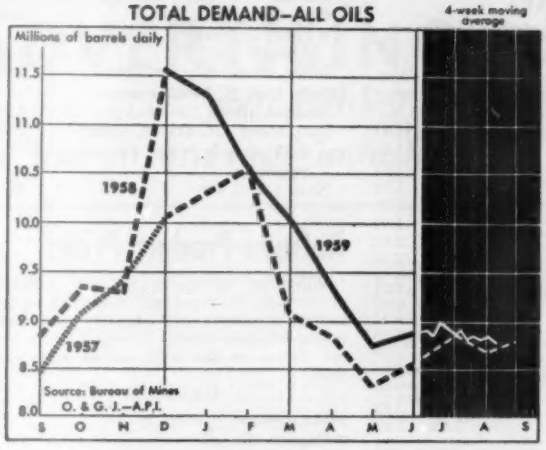
DAILY AVERAGE PRODUCTION FOR WEEK

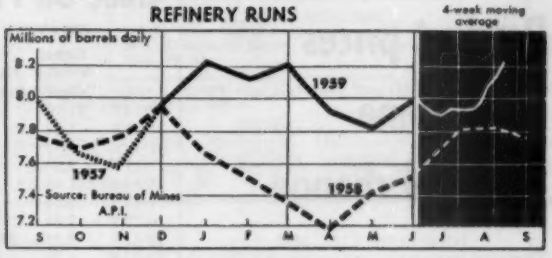
	September 12, 1959			Sept. 5
	Crude oil	Lease condensate	Total	total
Alabama	15,400		15,400	16,170
Arkansas	47,000	300	47,300	47,900
California	843,200		843,200	846,300
Colorado	126,000		126,000	126,400
Eastern	40,900		40,900	39,800
Florida	1,200		1,200	1,170
Illinois	214,900		214,900	216,200
Indiana	33,000		33,000	32,700
Kansas	†312,490		†312,490	†309,650
Kentucky	89,500		89,500	88,700
Louisiana	901,000	98,750	999,750	998,000
North	110,000	5,000	115,000	114,820
South	791,000	93,750	884,750	883,180
Michigan	29,900		29,900	27,900
Mississippi	137,800	3,770	141,570	139,750
Montana	80,800		80,800	81,500
Nebraska	64,300		64,300	63,800
Nevada	100		100	100
New Mexico	286,000	4,900	290,900	288,550
North Dakota	40,100		40,100	38,400
Oklahoma	†502,650		†502,650	†503,700
Texas	2,430,000	70,020	2,500,020	2,481,170
Dist. 1	42,000	2,000	44,000	44,430
Dist. 2	103,000	7,600	110,600	108,870
Dist. 3	315,000	35,800	350,800	350,800
Dist. 4	170,000	8,200	178,200	177,350
Dist. 5	28,500	300	28,800	28,600
Dist. 6	105,000	6,200	111,200	109,920
East Texas field	132,500		132,500	131,000
Dist. 7-B	132,500	100	132,600	131,520
Dist. 7-C	115,000	3,020	118,020	117,170
Dist. 8	975,000	4,200	979,200	966,350
Dist. 9	202,000	1,600	203,600	204,880
Dist. 10	109,500	1,000	110,500	110,280
Utah	111,900		111,900	114,800
Wyoming	345,300		345,300	344,100
Others	‡310		‡310	‡360
Total U. S.	6,653,750	177,740	6,831,490	6,807,120
Change from prev. week, up			24,370	
Canada	†476,400		†476,400	†549,000
Total U. S. prod., January 1-September 12			1,805,439,300 bbl.	
Same period last year (crude plus cond.)			*1,673,759,090 bbl.	

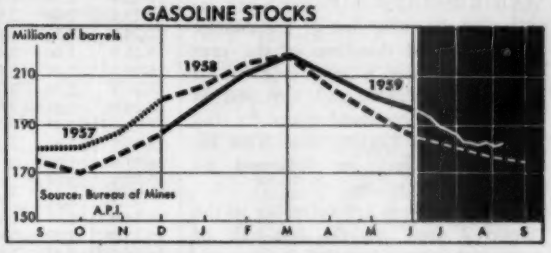
*Includes 40,129,670 bbl. condensate. †Week ended previous Monday. ‡Arizona, South Dakota, and Washington.

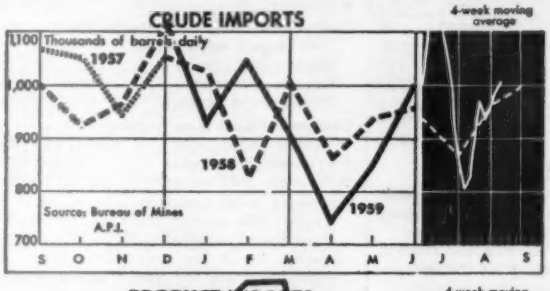
CRUDE-OIL PRODUCTION

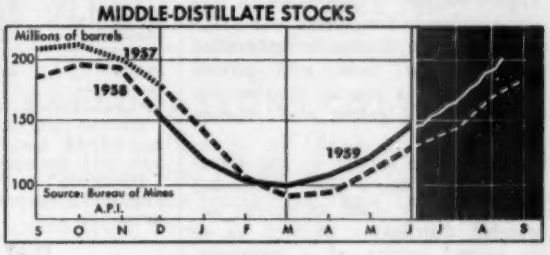


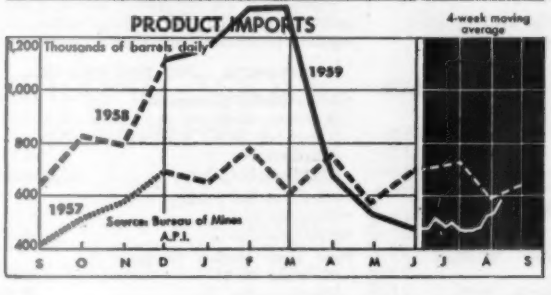


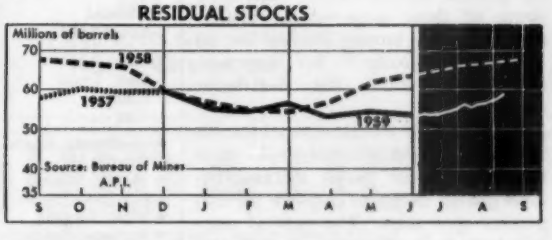












API REFINERY REPORT—SEPTEMBER 11, 1959

(Thousands of barrels)

District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, September, 1958 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,135	545.6	56.8	312.9	154.3	44,839	13,162	65,838	12,377	1,135	529.4	31.3	313.1	202.0
Appalachian:														
District 1	98	43.4	1.9	23.4	6.3	5,621	667	4,116	377	103	44.6	4.6	21.9	6.8
District 2	105	59.4	2.3	17.6	7.7	2,669	492	1,704	506	96	51.3	5.4	20.7	6.8
Ind., Ill., Ky.	1,508	794.4	71.4	293.3	148.7	32,055	7,794	28,435	5,883	1,387	239.5	39.5	305.2	128.7
Minn., Wis., Dak.	100	50.4	4.0	20.4	9.8	6,432	1,420	7,856	395	76	31.3	1.7	21.8	8.6
Okla., Kans., Mo.	746	443.9	4.4	214.4	20.0	17,334	1,575	12,076	954	704	401.2	12.3	171.4	21.4
Inland Texas	301	231.9	9.6	50.7	24.6	7,208	542	2,111	2,200	270	201.9	11.2	46.8	22.1
Texas Gulf Coast	1,906	900.6	103.7	393.0	150.5	21,059	3,576	18,555	6,436	1,798	910.1	90.4	470.2	197.9
La. Gulf Coast	670	369.0	49.6	146.6	39.7	9,592	1,783	7,473	1,436	665	383.5	53.5	158.0	46.8
N. La. and Ark.	72	34.4	0.3	17.1	4.1	4,651	986	1,848	190	86	36.8	5.8	20.8	6.6
Rocky Mountain:														
New Mexico	25	16.9	0.7	4.7	3.4	793	48	168	71	25	13.1	0.5	4.8	2.4
Other	309	145.3	3.7	62.1	31.3	4,608	381	3,037	1,147	285	130.0	5.6	58.3	30.0
West Coast	1,206	577.7	3.0	149.2	270.7	26,630	361	15,361	26,806	1,133	504.9	3.0	170.5	293.1
Sept. 11, 1959	8,181	4,212.9	311.4	1,705.4	871.1	183,491	32,787	168,578	58,778	7,763	3,977.6	284.4	1,783.5	973.2
Sept. 4, 1959	8,132	§4,207.1	276.0	§1,810.4	910.4	181,509	31,354	163,198	57,507	.....	.....	.....	.....	.....
Sept. 12, 1958	7,845	4,008.0	298.3	1,773.6	969.7	172,891	29,648	146,190	68,378	.....	.....	.....	.....	.....

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines. §Revised.

Product prices show some seasonal change

MAJOR PRODUCT PRICES are reacting to the influence of the change in seasons. At this time of the year the refiner takes a long look at his gasoline inventories and also sets in motion his operational plans for fall distribution of heating oils. This reexamination may be followed by minor shifts in prices.

Gasoline prices are softening in the Group 3 area. In the last half of August, the low of quotations for regular gasoline in the pipeline was 11.75 cents a gallon. Currently, unbranded distributors or those with private brands can buy regular gasoline for 11.25 cents a gallon plus pipeline charges.

In the area served by the Great Lakes Pipe Line, a large unbranded distributor may resell to smaller unbranded distributors as well as to his normal service-station customers. Some of these large-volume distributors may be buying for as low as 11.00 cents Group 3, but they normally buy under the distributor market.

On the Gulf Coast, quotations for 92-octane regular start at 11.00 cents a gallon on the cargo market, but there have been no reports of important spot sales. The general market feeling in the area is that this price could be shaded at least 0.25 cent a gallon on a firm offer for lifting near the end of the month.

Distillate prices on the Gulf Coast moved up by default. One supplier had been quoting 7.75 cents a gallon for No. 2 fuel while others were posting 8.0 cents. When the low man withdrew his quotation, the general market posting moved up to 8.0 cents.

Because of the high level of distillate stocks on the Gulf Coast and East Coast, distributors have not been in a hurry to fill secondary storage. It will take an early winter and low temperatures to move distillate prices back to normal before the end of the year.

Residual prices are reasonably firm on the Gulf Coast, but there have been reports of at least one New York retailer who is delivering to consumer tanks at the barge price.

Crude-Oil Prices

GRAVITY SCHEDULE

	Signal ★Hill,§ Calif.	Oklahoma	Gulf Coast Tex.*	West Tex.† N.M.	Wyo. (sour)
14-14.9	$1.76	....	....	....	....
15-15.9	1.84	....	....	....	$1.81
16-16.9	1.92	....	....	....	1.86
17-17.9	2.00	....	....	....	1.91
18-18.9	2.08	....	....	....	1.96
19-19.9	2.16	....	....	....	2.01
20-20.9	2.24	$2.49	....	$2.35	2.06
21-21.9	2.32	2.52	....	2.38	2.11
22-22.9	2.39	2.55	....	2.41	2.16
23-23.9	2.46	2.58	$3.44	2.44	2.21
24-24.9	2.53	2.61	3.46	2.47	2.26
25-25.9	2.60	2.64	3.48	2.50	2.31
26-26.9	2.67	2.67	3.50	2.53	2.36
27-27.9	2.74	2.70	3.52	2.56	2.49
28-28.9	2.81	2.73	3.54	2.59	2.54
29-29.9	2.87	2.76	3.56	2.62	2.59
30-30.9	2.93	2.79	....	2.65	2.63
31-31.9	3.00	2.82	....	2.68	2.67
32-32.9	3.06	2.85	....	2.71	2.71
33-33.9	3.12	2.88	....	2.74	2.75
34-34.9	3.17	2.91	....	2.77	2.79
35-35.9	3.22	2.94	....	2.80	2.83
36-36.9	3.27	2.97	....	2.83	2.87
37-37.9	3.31	2.99	....	2.86	2.89
38-38.9	....	3.01	....	2.89	2.91
39-39.9	....	3.03	....	2.92	2.93
40-40.9	....	3.05	....	2.95	2.95

*Low cold test crude. †Sour.

Effective dates of broad changes: California, 9-11-59; East of California, January 3-10, 1957; Pennsylvania Grade 9-12-59.

§Union Oil Co. of California and General Petroleum Corp. posting up to 25c less per barrel.

FLAT PRICES

Louisiana:	
Sweet Lake	$3.00
Texas:	
East Texas	3.05-3.25
Conroe	3.53
Van	3.08
Pennsylvania Grade:	
★ Bradford	4.40
★ Middle District	4.22
★ Southwest Pennsylvania	3.95
★ West Virginia	3.77
★ Buckeye Grade	3.62
Illinois Basin	3.00

FOREIGN

Canada:	
Leduc-Woodbend	2.53
Redwater (Alta.)	2.42
Smiley (Sask.)	2.18
Pembina	2.38
Venezuela:	
Cumarebo, 48°-49.9°, Tucupido	3.34
San Joaquin, 41°-41.9°, Puerto La Cruz	3.08-3.10
Oficina, 35°-35.9°, Puerto La Cruz	2.80
Tia Juana medium, 26°-26.9°, Amuay*	2.30
Quiriquire, 16.0°-16.4°, Caripito	2.10
Lagunillas heavy, flat, Las Piedras*	2.10
Bachaquero, flat, 15°-16°, Las Piedras*	1.88

Prices for all crudes of 24° or lighter vary 2 cents per degree change, up or down. All crudes heavier than 24° vary 2.5 cents per half-degree gravity change.

*Also available at La Salina at 3 cents per barrel less.

Middle East, Persian Gulf (cargoes f.o.b. lifting port):	
Arabian, about 34°, Ras Tanura	$1.89
Iranian, 34.0°-34.9°, Bandar Masur	1.86
Iranian, 34.0°-34.9°, Abadan	1.81
Iraq, 36.0°-36.9°, Fao	1.82
Kuwait, 31.0°-31.9°, Mina-al-Ahmadi	1.67
Qatar, about 41°, Um Said	2.05
Middle East, E. Mediterranean:	
Arabian, about 35°, Sidon	2.29
Iraq, about 35°, Tripoli, Banias	2.29
Far East (cargoes, f.o.b. Lutong, Sarawak):	
Seria Light, 37°	2.57

Refined-Product Prices

Following quotations are for refinery products in cents per gallon moving in interstate shipments on Wednesday each week unless otherwise noted. Crude-oil prices are per barrel at the wells unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):	
★ Regular (91 octane)	11.25-11.75
★ Premium (99 octane)	14.00-14.50
Gulf Coast (cargoes for coastwise or export movements):	
Regular (90 octane)	10.75
Regular (92 octane)	11.00
Premium (98 octane)	12.25
California (rack) (Los Angeles):	
★ Regular (88 octane)	11.65-12.25
★ Premium (94 octane)	12.65-13.25
★ Premium (100 octane)	14.15-14.50
Caribbean area (cargoes):	
Regular (87 octane)	10.375
Premium (97 octane)	12.00

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):	
Kerosine 42-44	9.00-9.50
Diesel oil (58 d.i. and above)	8.75-9.25
Distillate No. 1	8.75-9.25
Distillate No. 2	8.00-8.50
Gulf Coast (cargoes):	
★ Kerosine 41-43	8.375
★ Distillate No. 2	8.00
New York Harbor (barges):	
Kerosine 41-43	9.60
Distillate No. 2	9.10
Diesel fuel, 48-52 d.i.	9.40
Caribbean area (cargoes):	
Distillate No. 2	8.125

★Denotes change from previous week.

RESIDUAL FUEL (BBL.)

Mid-Continent (Group 3):	
Residual fuel (max. 1% S)	$1.60-1.70
Gulf Coast (cargoes):	
Bunker C fuel	$2.00
New York Harbor (barges):	
★ Bunker C fuel	$2.37-2.47
Caribbean (cargoes):	
Bunker C	$2.00
California (rack):	
Bunker C fuel, Los Angeles	$2.15

Tanker Rates (Long Ton)

(Latest reported spot fixtures)

Gulf-USNH, dirty (ATRS —32.5%)	$1.92
★ Carib.-Brazil, clean (ATRS —47.5%)	2.78
★ Carib.-Brazil, dirty (ATRS —52.5%)	2.52
★ PG-Spain, dirty (USMC—37.5%)	6.81

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FOR SALE—30,000 ft. New 4½" OD-15.5# PE Tubing. 150,000 ft. 10¾" OD-41.85# No. 1 Grade Used Line Pipe, PE or T&C. Lundquist Pipe & Supply Co. 325 Wright Bldg. Tulsa 3, Oklahoma. Phone LU 5-8850.

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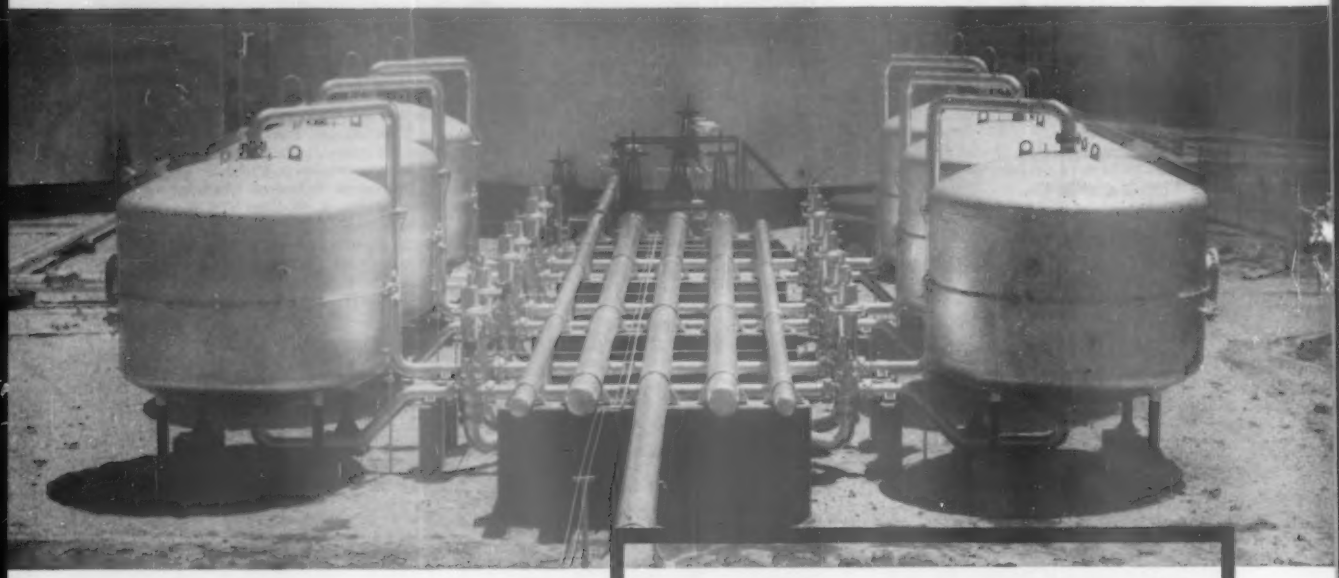

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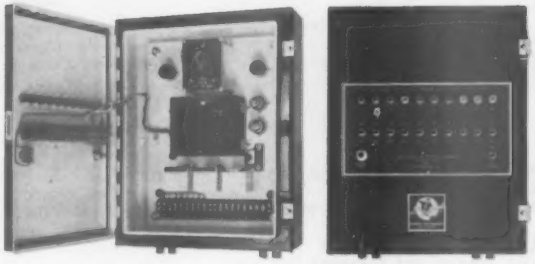

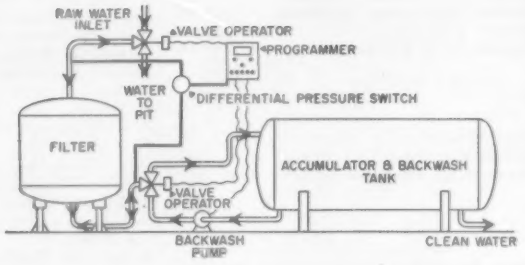

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